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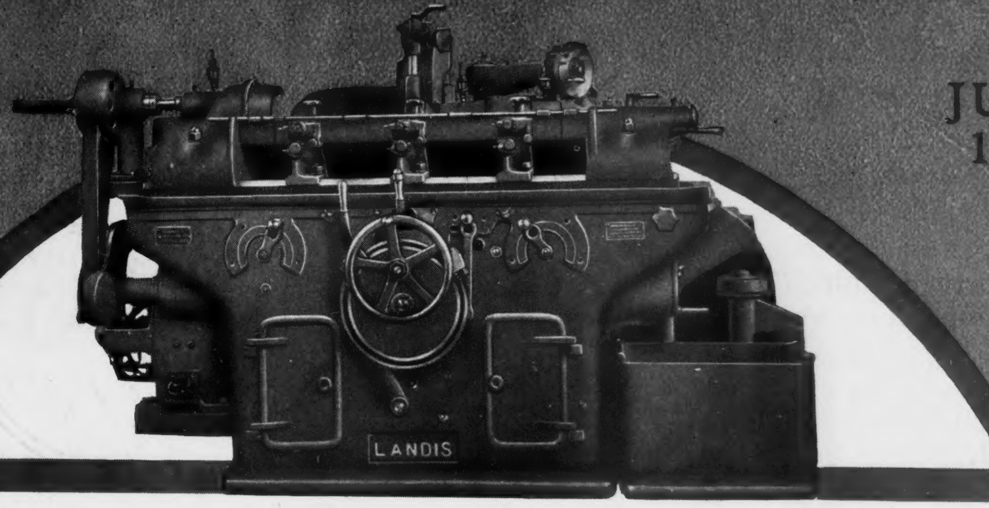

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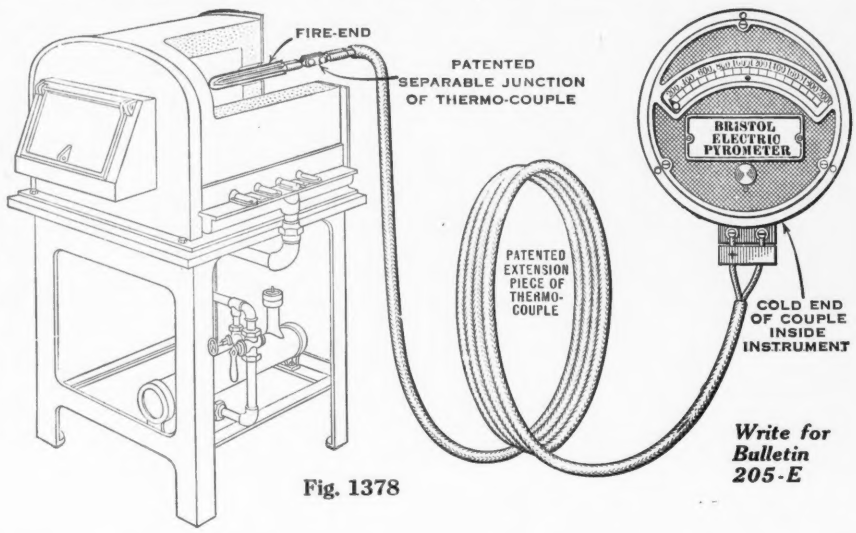

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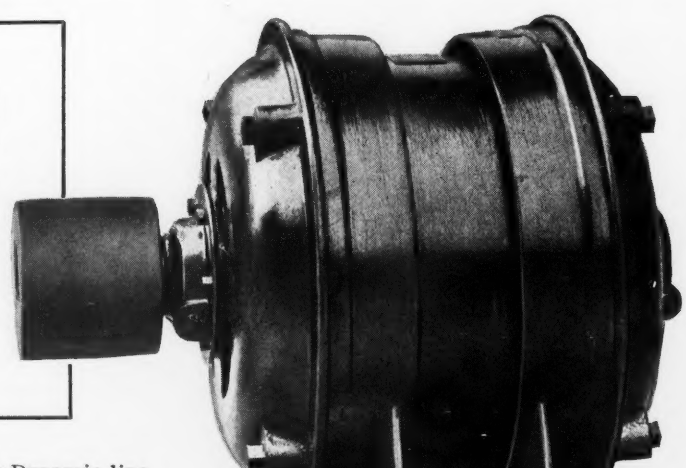

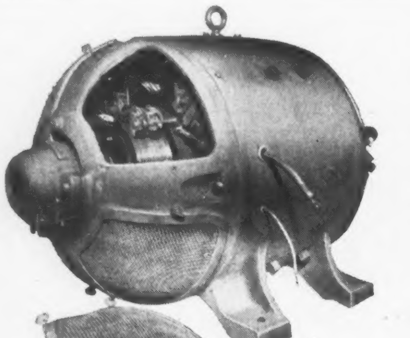

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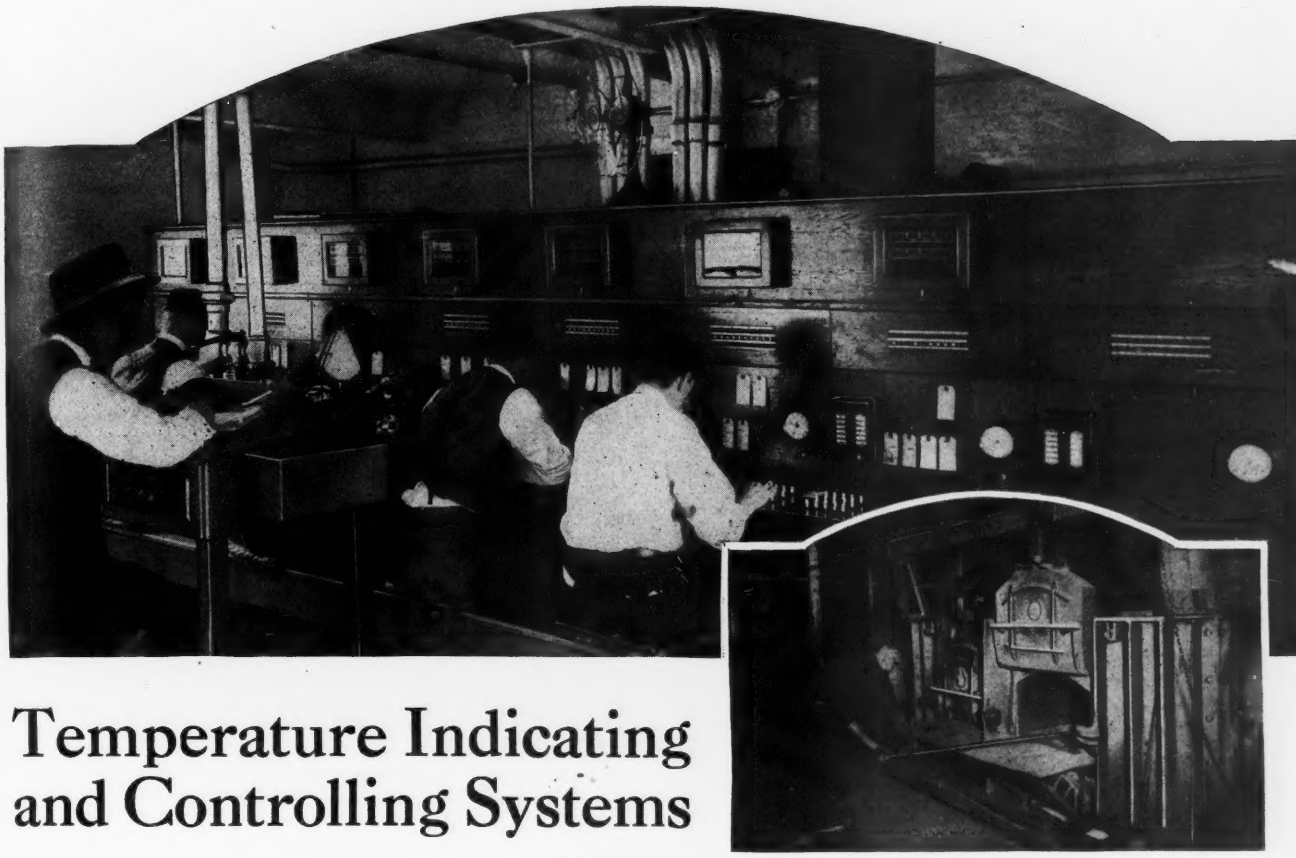


Temperature Indicating and Controlling Systems

Different Types of Thermo-electric Apparatus for Indicating and Recording Temperatures in Heat-treating Furnaces and for Controlling Temperatures by Signals and by Automatic Regulation—First of Three Articles

By FRANKLIN D. JONES

THE quality of some manufactured products depends largely upon the skill and experience of workmen who control entirely, or in part, whatever manufacturing processes are required. On the contrary, other processes and their products are regulated largely, or entirely, by mechanical and electrical apparatus, the quality being controlled by means which are unvarying and capable of uniform results that agree with predetermined and approved standards. While experience is indispensable in the heat-treatment of steel, nevertheless much can and has been done to avoid dependence upon experience and judgment, by the development and use of scientific instruments and methods—which is equally true of many other branches of work, both in the engineering and other fields.

The operation of a well equipped heat-treating plant is based primarily upon the requirements which have been found essential for obtaining whatever physical characteristics are needed in the steel. In general, the heat-treatment of steel involves first, determining how the desired physical qualities are to be obtained, and second, what apparatus will make it possible to secure these results without guesswork or the employment of haphazard methods. The metallurgist and steel-maker, by the development of improved processes, have made it possible to produce steels which meet practically all physical requirements, although it is apparent that scientific methods as applied to smelting and refining processes may be almost completely offset and the best grades of steel injured or spoiled, if the heat-treating processes depend merely upon judgment rather than upon definite and precise knowledge. The recognition of this simple fact is indicated by the practice and equipment found in the heat-treating departments of modern plants, especially where tools, machinery of various kinds, or steel products in general are manufactured on a large scale and accurate methods of insuring uniform heat-treatment are essential.

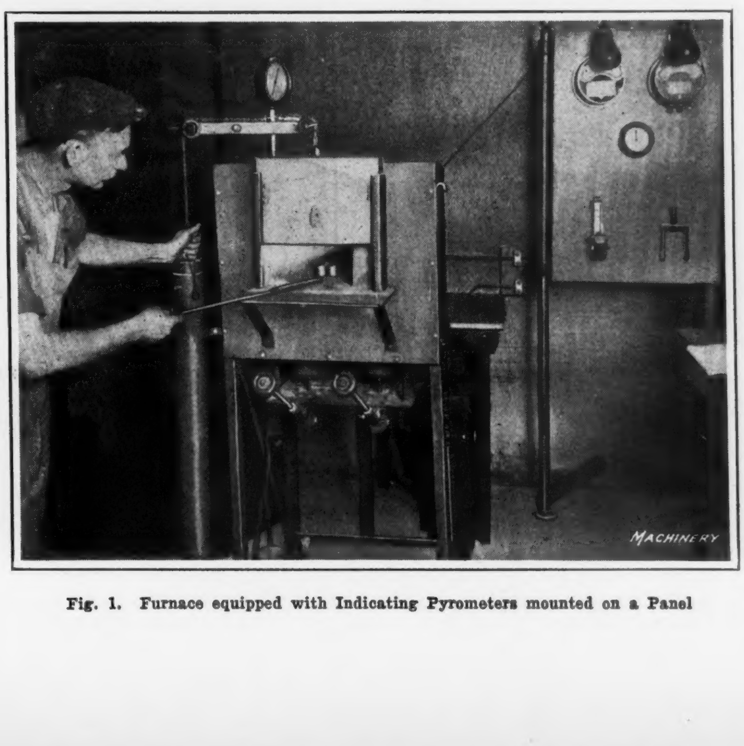


Fig. 1. Furnace equipped with Indicating Pyrometers mounted on a Panel

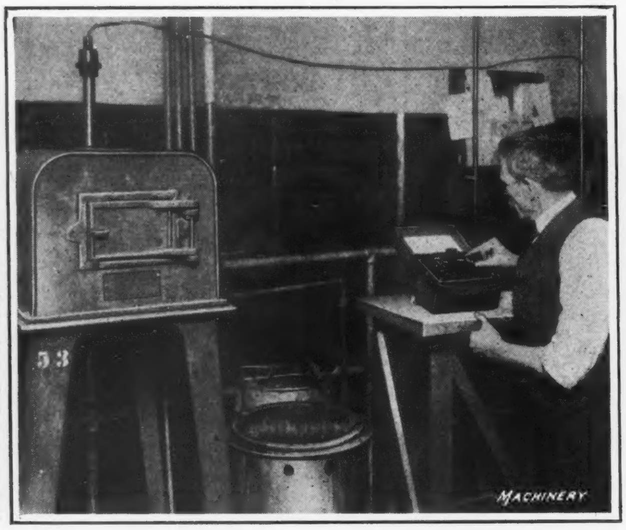


Fig. 2. Taking a Temperature Reading of a Heat-treating Furnace with an Indicating Pyrometer of the Potentiometer Type

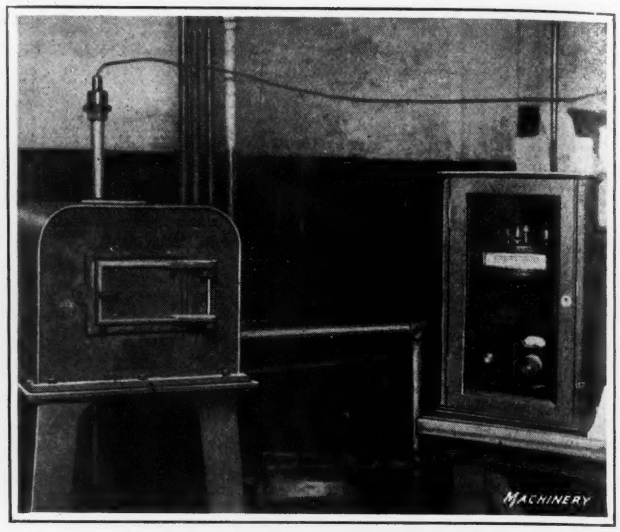


Fig. 3. Indicating Potentiometer so arranged that Temperature Deviations are read directly from Galvanometer Scale

General Requirements for the Heat-treatment of Steel

The object of heat-treating processes as ordinarily applied to steel machine parts is to change the physical structure of the material and make the steel either softer or harder. When the steel is treated to make it harder than steel in the natural or untreated condition, the object may be to provide hard wearing surfaces, greater stiffness or resistance to deflection, or a degree of hardness that will enable edged tools made from the steel to cut other metals or softer materials. A reduction in the degree of hardness may be necessary to permit cutting the metal, as when steel is annealed, or to reduce brittleness by sacrificing hardness, as when hardened tools are tempered. In brief, then, the object of heat-treatment is to obtain physical properties that will meet the mechanical requirements. If the heat-treating process is applied to duplicate parts which are to serve the same purpose, the advantage of uniformity in the physical qualities of those parts will be apparent to all experienced mechanics and engineers.

In order to control various heat-treating processes in a definite and specific manner, considerable equipment has been developed during recent years, and the purpose of this article is to present a general review of the approved methods and apparatus for indicating, controlling, and recording temperatures, especially in connection with the hardening, tempering, annealing, or casehardening of steel parts. The proper heat-treatment of steel depends upon several general requirements which include the correct degree of temperature in the furnace, the proper atmospheric conditions in the furnace, a uniform and correct temperature throughout the part being heat-treated, correct timing of the heating period to obtain a uniform temperature, and the recording of data for future reference.

Maintaining the correct temperature in the furnace involves first, determining what that temperature should be, and second, adopting means of indicating or measuring the temperature. The proper degree of temperature depends not only upon the kind of heat-treatment—that is, whether hardening, tempering, etc.—but also upon the chemical composition of the steel, and the desired physical qualities in the heat-treated product. For instance, high-carbon or tool steel should be hardened at a temperature depending upon the amount of carbon it contains, as is generally known. If the temperature is too low, the steel is not hardened by a sudden cooling, and if it is too high, the structure of the hardened steel is relatively coarse and the steel weakened. When the temperature is what it should be, a structure of fine grain and a better product is the result. While steel may be hardened within quite a wide range of temperatures,

Fig. 4. Connecting Pyrometer in Circuit with One of Several Thermo-couples by Means of Push-button Switch

Fig. 5. Selective Switch of Rotary Type for connecting Pyrometer in Circuit with Different Thermo-couples

assuming that it has been heated above what is known as the decalescent points, the best results are obtained within a comparatively narrow range. In the case of high-speed steel subjected to heat-treatment, the changes that occur in the structure of the steel are affected by the alloys which give the high-speed steel its peculiar and valuable properties of retaining hardness, even when red-hot; consequently, the method of heat-treatment is quite different from that employed for plain carbon steel. While this fact is well known, it is mentioned in order to emphasize the point that correct heat-treating temperatures are closely related to the chemical composition of the steel, and since the addition of a small percentage of some element such as carbon will greatly affect the nature of the steel, it follows that a given heat-treating process should be based on the composition of the steel and not be left merely to someone's judgment. It is evident, then, that guessing hardening temperatures or judging them by the eye or by the color of the heated piece is not the way to obtain uniform results.

Fig. 6. Pyrometer and Selective Switch which is located in the Office of the Superintendent

The second general requirement previously mentioned was the proper atmospheric conditions in the furnace. In general, the atmosphere should be non-oxidizing so that scale will not be formed on the surface of the work. The condition of the atmosphere in furnaces of the type which burn some kind of fuel such as gas, oil, or coal depends upon the relation between the fuel and air supply. If more air is admitted to the furnace than is needed for the combustion of the fuel, the excess of oxygen will attack the heated steel, thus forming an oxide or scale. To prevent this requires proper regulation of the air and fuel supply, the object being to admit just enough air to support combustion, or slightly less, in which cases the atmosphere will be either neutral or slightly reducing. The condition of the furnace atmosphere, aside from changes resulting from fuel and air regulation, might be affected by the type of furnace; but as there are many different types and designs, and their selection depends upon the quantity of work to be heat-treated as well as upon the desired quality, this subject will not be considered further here, the object of the present article being to deal primarily with regulating and controlling apparatus.

Obtaining a uniform temperature throughout parts subjected to heat-treatment may depend upon the length of time allowed for heating, the method of placing work in the furnace (especially when a number of parts are heated together) and on the design of the furnace itself. If we assume that the temperature is uniform in that part of the furnace containing the work, it does not follow that the latter will be heated uniformly. When parts are piled upon one another so that the same surface areas are not exposed to the direct action of the heat, a lack of uniformity in heating will be the result. Another point to be considered is that some sections heat more quickly than others, especially if the work is of irregular shape; consequently, the length of the heating period must be long enough to allow uniform heating throughout, which is an important requirement. The mass of the piece and the surface exposed to the heat will, of course, affect the time required for thoroughly saturating it or heating it uniformly. In this connection the clock may be used to advantage in conjunction with the pyrometer or temperature indicator, and, in fact, is indispensable.

When a certain heat-treating process has produced the desired results, and all the elements entering into that process are known, such as the temperatures, length of heating period, etc., a permanent record may be of considerable value. The graphic time-and-temperature records obtained

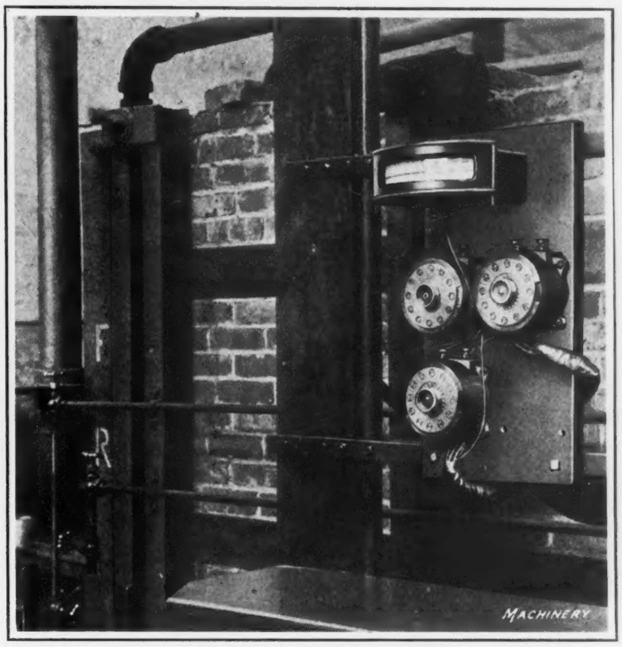


Fig. 7. Pyrometer which can be connected with Thirty-three Thermo-couples by Means of Rotary Switches

from recording instruments of different types have made it very convenient to obtain and keep such data for future reference. Instruments of this class also serve another useful purpose in that they show the daily performance of one or more furnaces and enable records to be preserved covering a considerable period of time. While such records are being made, they may be referred to by furnace attendants and afterward by foremen or superintendents whenever convenient. These records also enable past and existing conditions to be compared, and if the performance in the heat-treating plant is not up to required standards, the reasons may be determined and the record may also indicate what furnace or operator is at fault.

How Temperatures are Determined by Thermo-couple and Indicating Instrument

Before describing typical forms of indicating and controlling apparatus, the general principle governing the operation of temperature-measuring instruments or pyrometers, such as are commonly used in steel heat-treating plants, will be briefly referred to. There are a number of types of pyrometers, such as the thermo-electric pyrometer, resistance pyrometer, radiation pyrometer, and optical pyrometer, but the thermo-electric pyrometer is the type used in conjunction with most steel heat-treating processes. A thermo-couple consisting of two pieces of dissimilar metals is placed at some point within the furnace and is connected by wires with a meter or indicator which may be close to the furnace or in some other part of the plant. That end of the thermo-

couple which extends into the heated chamber is known as the "hot end," and the two pieces of dissimilar metals do not touch except at this hot end. The opposite or "cold ends" which are free or separated are connected by wires with whatever indicating or recording apparatus is installed. When the hot end is heated, a feeble electric current is generated. The electromotive force thus developed depends upon the kind of metal of which the thermo-couple is made, and upon the difference between the temperatures of the hot and cold ends. (Methods of preventing errors in readings due to cold-end temperature variations will be described in a subsequent installment of this article). The current is conducted by wires leading to the meter or indicating part of the pyrometer outfit. The instrument may be calibrated or graduated to give readings directly in degrees F. or C.

Fig. 8. Section of a Central Control Board for regulating Temperatures of Different Furnaces by Means of Signal Lights

The method of utilizing the current to indicate degrees of temperature varies with pyrometers of different makes. Many pyrometers are so designed that the indicating hand or pointer is displaced, by the direct action of the current upon a moving element, an amount depending upon the strength of the current generated. In this case, the indicating instrument is a form of galvanometer or millivoltmeter. As a feeble current is generated, a sensitive instrument is required, and one of the important features is the method of arranging and supporting the moving element so that it is actuated by slight changes in the strength of the current.

The pyrometer may be of either a high- or a low-resistance type, depending upon the amount of internal resistance. For instance, this internal resistance may be only 5 ohms in a low-resistance pyrometer and 500 ohms or more in a high-resistance instrument. In a high-resistance pyrometer, less of the current generated by the thermo-couple is utilized by operating the moving or indicating element. The object of introducing high resistance is to avoid errors due to changes of resistance in circuit, such as would result from atmospheric changes of temperature or from changes in the length of the lead wires or of the thermo-couple itself. When the internal resistance of the pyrometer is, say 600 ohms, changes in the resistance of the circuit such as would result from changing the length of the leads from a few feet to several hundred feet, may be entirely negligible because the change of resistance represents such a small percentage of the total resistance. There is a practical limit, however, to the amount that the resistance should be increased, as the greater the resistance the more difficult it is to construct a movable element which will readily respond to changes in the strength of the current resulting from variations in the temperature of the thermo-couple. While low-resistance instruments are comparatively cheap, they are not so accurate as the high-resistance pyrometers, and should be used only when the leads connecting with the thermo-couple are short, on account of the greater resistance changes in long leads. The contact resistance at the binding posts, where the leads are joined to the couple and to the instrument, may also affect the readings, and these contacts should be very good for a low-resistance instrument. Most of the pyrometers of the millivoltmeter type used in connection with the heat-treatment of steel are high-resistance instruments. The high-resistance type is not only desirable when the leads are long, but it is especially adapted for installations where one pyrometer is connected (by a multiple switch) to several different thermo-couples located at various distances from the indicating instrument.

Another type of pyrometer differs from the millivoltmeter type in that the indicating instrument operates upon a different principle. Instead of utilizing the current to displace either a suspended or pivoted part, the electromotive force of the thermo-couple is opposed by an electromotive force of known value usually derived from a dry cell contained in the instrument. When the balance between the opposing forces is complete, a galvanometer is used to show that no

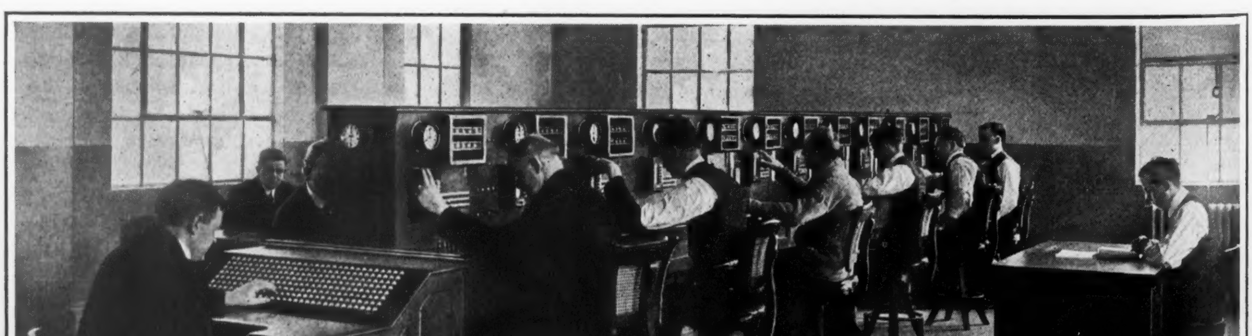


Fig. 9. Another Central Control Board and Signal System

current is flowing, and then the electromotive force of the thermo-couple is indicated directly by the position of a movable contact. This type of pyrometer is known as a potentiometer to distinguish it from the millivoltmeter type. The potentiometer requires some outside source of current, but it gives accurate readings and is not affected by resistance changes in the thermo-couple circuit. Both types and variations in their design will be referred to later. It will be understood from what has preceded that the meter or indicating instrument of a pyrometer, either of the millivoltmeter or potentiometer types, may either be arranged to show the temperature at any time by a graduated scale and pointer, or may be designed to trace a record of temperature changes upon a chart.

Thermo-couples for Pyrometers

Aside from the design or type of indicating instrument or meter, pyrometers differ in regard to the metals used for the thermo-couples. There are two general classes of metals used for this purpose, known as base metals and rare metals, the former being the more widely used. The latter are much more expensive, but they are adapted to higher temperatures. Base metal couples are ordinarily used in conjunction with the heat-treatment of carbon steels, but rare metal couples are often used in preference in the case of high-speed steels. Base metal couples are usually made either of some nickel alloy or of iron-constantan, and rare metal couples of platinum in conjunction with a platinum alloy. The base metal couples have several advantages, especially as applied to pyrometers for use in heat-treating plants. In the first place, the base metal couple generates an electromotive force which is several times as great as that derived from a platinum alloy couple; consequently, the indicating instrument can be made less delicate and is not so likely to become deranged. Another advantage is that for a unit increase in the temperature of a base metal couple there is approximately a uniform increase in electromotive force, the relation between the two being represented by a line that is nearly straight. The result is that the pyrometer has graduations or divisions that are practically equal or even, which is preferable to a scale having short divisions for the lower temperatures and longer ones for the higher temperatures, or vice versa. Still another advantage is that the increase of resistance due to an increase of temperature is very low as compared with a rare metal couple. It is essential that all thermo-couples which may be used at different times in conjunction with a pyrometer generate the same electromotive force for a given temperature; in other words, the thermo-couples should be interchangeable. Without this uniform relationship between the temperature and the electromotive force generated, the pyrometer readings will not be correct. In addition to this quality of uniformity or accuracy, a reasonable degree of durability is also important.

While much could be written regarding the relative merits of different types of equipment and their constructional features, this article will be confined more especially to a discussion of the various forms of apparatus now manufactured and the uses to which they are adapted, as well as the methods of application in different heat-treating plants.

Pyrometers of the Indicating Type

Many of the pyrometers used in heat-treating plants may be designated as the "indicating" type, since the temperature variations are shown by the position of a hand or pointer relative to a graduated scale. The indicating instrument may be located close to the furnace or in some central station or controlling room. When it is by the furnace, the furnace operator controls the temperature either according to his experience with similar work, or possibly by reference to data previously recorded. This is a common method in small plants, but where a large heat-treating department is installed, a centralized system of control is quite general. The exact methods of controlling the furnaces either indirectly through attendants or directly, from a single controlling station, will be explained later.

Fig. 1 shows two Hoskins indicating pyrometers (Hoskins Mfg. Co., Detroit, Mich.) mounted on a panel located near a furnace. These pyrometers are of the general type which indicates temperatures by means of a millivoltmeter, the moving element of which is actuated by the strength of the current generated by the thermo-couple. When a reading is desired, the circuit connecting the thermo-couple at the furnace and the indicating instrument is closed by a switch, and then the pointer swings over opposite a graduation which represents the temperature. These pyrometers happen to be of the low-resistance type, as the installation in

Fig. 10. Four Central Control Boards, Each arranged for Connection with Thirty-six Thermo-couples

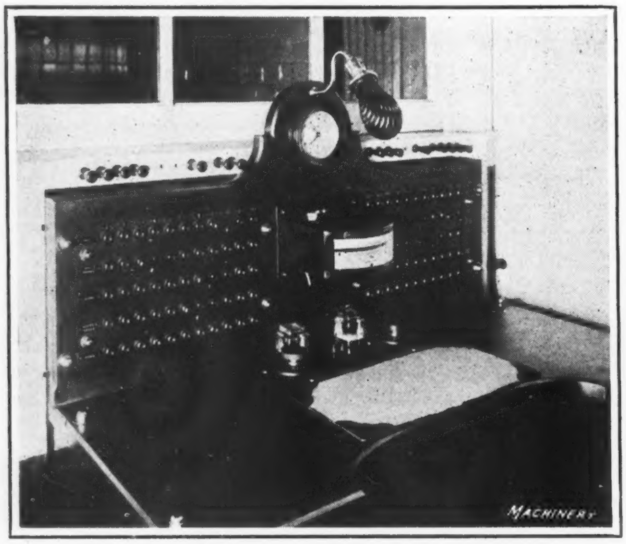


Fig. 11. Control Board for regulating Different Combinations of Colored Lights which indicate Desired Temperature Changes

this case is small and the lead wires short. The high-resistance type would be recommended for long leads and in case temperatures from several thermo-couples were to be indicated by one meter, or if the cold-end regulation were to be taken care of by means of thermo-couple extension leads, as explained later.

An indicating pyrometer of the potentiometer type, made by Leeds & Northrup Co., Philadelphia, Pa., is shown in Fig. 2. This instrument, which is shown in use, contains a slide wire through which passes a small and accurately controlled current derived from a battery. Each division of length along the slide wire corresponds to a definite difference in potential. The thermo-couple at the furnace and the galvanometer are connected in series, and are attached to the slide wire at one end, and at the other to a movable contact which is free to slide along the slide wire. The electromotive force generated by the thermo-couple is thus opposed in direction to the slide wire potential. When the galvanometer shows that there is no current in the thermo-couple circuit, the electromotive force of the thermo-couple is indicated directly by the position of the movable contact. The adjustment of the potentiometer is effected by an external force and not by the thermo-couple. The adjustment of the indicating pyrometer shown in Fig. 2, is effected by hand, but an instrument of the recording type (referred to later) has a small electric motor which supplies power for the adjustment, the direction in which power is exerted being controlled by the position of the galvanometer needle. When taking a reading, a key is depressed and the knurled head turned until the galvanometer needle returns to a position of balance. When readings are to be taken from more than one thermo-couple, the key is allowed to remain in the depressed position and a multiple switch is used to connect the instrument with the different thermo-couples.

In Fig. 3 is shown another type of indicating pyrometer which differs from the one shown in Fig. 2 in that the temperature dial is set to the temperature desired in the furnace, and the deviation from this temperature to the extent of 100 degrees either high or low is read directly from the galvanometer scale. In this way, the operator can set the instrument to the temperature wanted and watch the galvanometer come to the zero position, when the temperature will be correct. The instrument can be used with more than one thermo-couple the same as the instrument in Fig. 2. Only one setting of the dial is required for each thermo-couple.

Selective Switches for Connecting Pyrometers with Different Furnaces

When plants are equipped with two or more furnaces, one pyrometer may be used to indicate the temperature in each furnace at different intervals by employing selective switches which enable the indicating instrument to be connected with the thermo-couple circuit of any furnace. These selective switches are made in different forms, some being of the ordinary swinging knife type, others of the push-button type, and still others arranged to rotate for connecting the pyrometer or indicating instrument with different circuits. A push-button switchboard and pyrometer, made by Taylor Instrument Companies, Rochester, N. Y., is illustrated in Fig. 4. In this instance, the workman is pressing button No. 3, and the indicator above (which is a high-resistance type) shows the temperature of the furnace on that circuit. Selective switches of the rotary type are shown in Figs. 5, 6, and 7. Switches of this general type are simply turned to different positions as indicated by numbers on the switches representing various thermo-couples in the furnaces. Since the current generated by the thermo-couple is very feeble in any case, it is essential to use a selective switch which maintains good contact surfaces throughout the life of the switch, as otherwise errors in readings will occur. In some instances, the contacts of improperly designed switches are partially insulated by foreign material or oxide coatings on the contact surfaces, and an error in the reading is thus introduced.

Fig. 5 shows a Bristol pyrometer (Bristol Co., Waterbury, Conn.), and illustrates how the selective switch is used. The Brown high-resistance pyrometer shown in Fig. 6 (The Brown Instrument Co., Philadelphia, Pa.) is installed in the office of the superintendent, who is taking a reading from one of the spring tempering furnaces installed in this plant. Fig. 7 shows a high-resistance pyrometer, made by the Wilson-Maeulen Co., 783 E. 142nd St., New York City, which, by means of the three eleven-point rotary switches shown, can be connected with thirty-three different thermo-couples. These switches are so interconnected that no two thermo-couple circuits can be connected with the indicator simultaneously.

Control of Temperature by Signals

The temperature of heat-treating furnaces may be controlled in four different ways: First, the furnace operator may take the pyrometer readings and regulate the furnace according to his own judgment; second, the operator may simply adjust the furnace to maintain a given temperature according to signals from a man in charge of the temperature control for all the heat-treating furnaces; third, the signals of the furnace operator may be controlled automatically by a special form of pyrometer which is previously set

Fig. 12. A Group of Temperature Signal Lights located above Furnaces

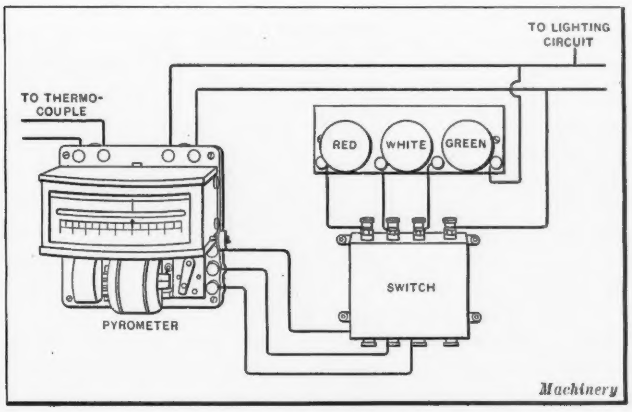


Fig. 13. Diagram illustrating Pyrometer and Other Equipment for automatically controlling Temperature Signals

for whatever maximum and minimum temperatures are desired; and fourth, the control may be entirely automatic. When the control is by some method of signaling, either colored lights or a bell may be used. If lights are employed, there are generally three—a red, white, and green combination being common. These lights are placed near the furnace. The red light may show that the temperature is too high, the white light that it is correct within certain limits (possibly 15 or 20 degrees) and the green light that it is too low. Lights are sometimes used in combination to vary the signals. For instance, when a furnace is loaded with work, the temperature is reduced considerably, the amount depending upon the size of the work and the number of pieces inserted. When the temperature has increased to a certain point, two lights may be switched on to show that it is still considerably below the required temperature, and then one light may be used to show that it is approaching the correct temperature but is still somewhat low. Finally, a different light may indicate that the correct temperature has been reached.

This simple method of signaling by lights can be readily understood by furnace operators, and it has been quite generally employed. In some cases it is considered preferable to have an alarm or bell which will attract attention. Such bells may be used in conjunction with lights, so that the attention of the operator is directed immediately to any change in the light signals. The Brown alarm pyrometer has adjustable arms for maximum and minimum temperatures, and when the pointer comes into contact with either arm, a circuit is completed, thus ringing the bell. Means are provided for readily adjusting the position of these arms.

Central Control Boards for Temperature Signal Systems

In large plants equipped with many different furnaces and a signal system, the central control board resembles somewhat a telephone switchboard. A section of one of these control boards at the plant of the Ford Motor Co. is shown in Fig. 8. The men seated in front of this board operate the signal lights, each man controlling a number of furnaces. When a temperature reading from any one furnace is desired, the thermo-couple circuit of this particular furnace is closed by one of the push-button switches, operated by the left hand, as shown in the illustration. The switches seen on the table or horizontal part of the control board are used to flash the signal light; a miniature light of corresponding color then shows, there being three horizontal rows of different colored lights located, in this installation, to the right of the push-button switch-box. The lights and switches are numbered to correspond to the numbers given to different furnaces. The temperature of whatever furnace is in circuit is shown by a pyrometer in a compartment located beneath the control board table. The pyrometers used in conjunction with this particular control board are the Hoskins indicating type.

Another central control board and signal system in use at the Ford plant is shown in Fig. 9. Here, Le Chatelier pyrometers, manufactured by Charles Engelhard, 30 Church St., New York City, are installed. The switches on this control board for the thermo-couples and signal lights are arranged in the same way as described in connection with Fig. 8. Both of these boards have signaling devices similar to annunciators which enable the furnace attendants to send back signals when necessary. The control board shown in Fig. 9 is double, operators being seated along both sides. The data needed for each heat-treating operation is marked on tags or tickets which hang on hooks in front of each man at the control board. All information that may be required for heat-treating any part is obtained from records which have been compiled from past experience and practice. The clocks seen on the control board are electrically controlled and operate in unison with clocks at the different furnaces. The man at the left of the illustration, who is seated in front of a separate control board, is able to check the readings at different points in order to see that the system is working properly.

Another signal system which differs in its arrangement from those previously described is shown in Fig. 10. This view shows only half of the control board equipment. In the complete installation there are eight of these control

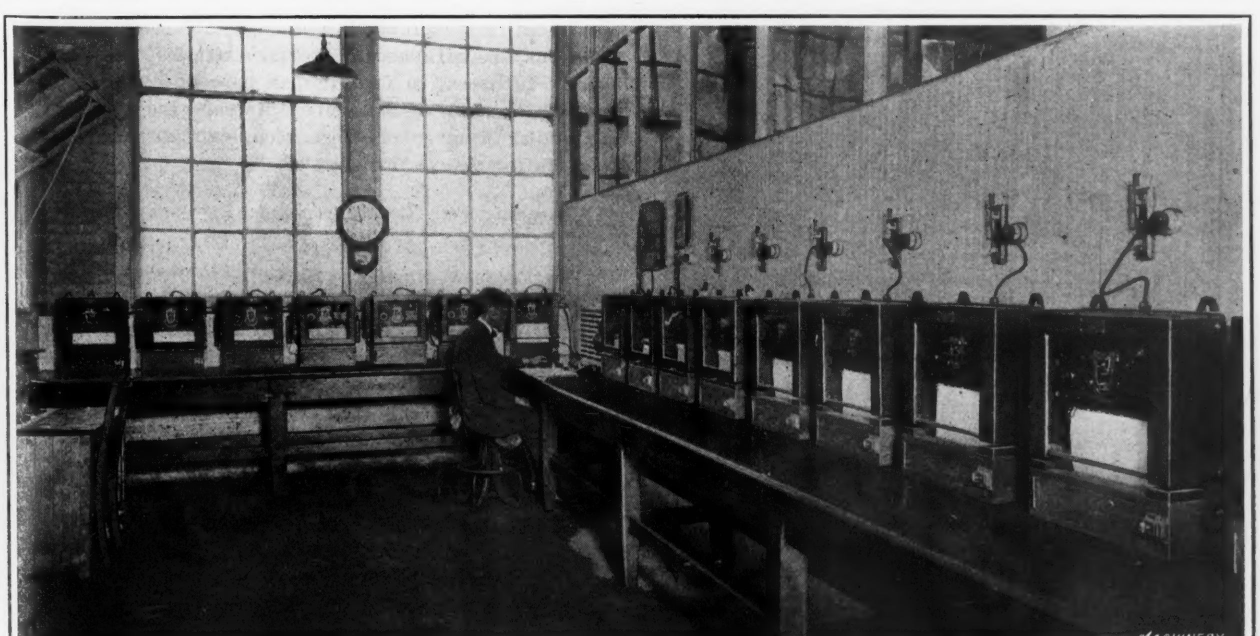


Fig. 14. Recording Pyrometers which automatically control Signal Lights and at the Same Time produce Graphic Records of the Temperatures

boards and each one is connected with thirty-six thermo-couples. The indicating instrument of each control board is in the center of the table and at the left-hand side there are eighteen double-throw switches for connecting thirty-six thermo-couples in circuit. On the vertical face of the control board the signal-light switches and miniature lights are located. Beneath each horizontal row of three lights are the three corresponding switches, and these are located in the same relative positions as the thermo-couple switches on the table. This is another Engelhard installation.

The signal board at the plant of the Fisher Body Corporation, Detroit, Mich., is illustrated in Fig. 11. The Brown pyrometer in the center of the board has an extremely high resistance of 1200 ohms. This board is arranged to control three lights for each thermo-couple, the colors being red, white, and green. With these lights, five combinations may be obtained consisting of the plain or solid colors and the combinations of red and white and white and green. The bank of signal lights is located well above the furnaces, as shown in Fig. 12, and the lights may be seen from both sides, one side being a duplicate of the other. Whenever the furnace temperature is too high or too low, the plain green or red lights are flashed on, as the case may be, and a large electric gong rings. This board, and the table in front of it, are both made of slate, and a clock is located just above the pyrometer, as the illustration Fig. 11 shows.

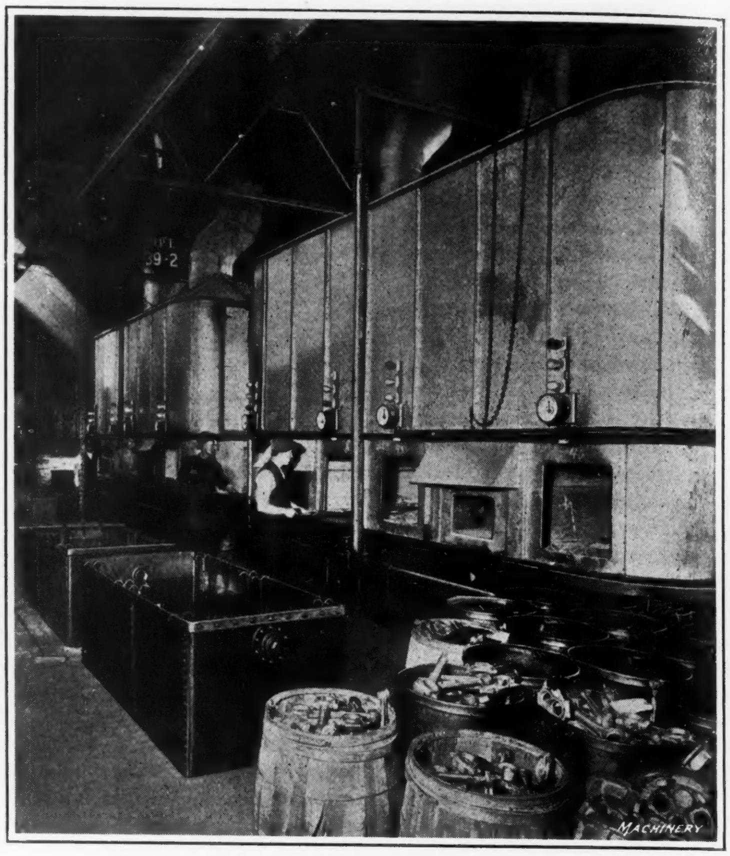


Fig. 15. Lead Pots in the Heat-treating Department provided with Signal Lights and Deviation Meters to indicate Correct or Incorrect Temperatures

Automatic Control of Temperature Signals

In order to dispense with the services of the man who controls the temperature signals from a central station, automatic signaling pyrometers have been developed. The Brown automatic signaling pyrometer is very similar to the type used for controlling furnace temperatures automatically, which will be described in a subsequent installment of this article. The signaling pyrometer is so arranged that the pointer is depressed at intervals of ten seconds upon contacts corresponding to the red, white, and green lights. The particular contact upon which the pointer is depressed depends, of course, upon the position of the pointer which, in turn, varies according to the temperature. The three contacts may be adjusted to a position corresponding to the temperature to be maintained. The periodic movements of the pointer for depressing it upon the contacts are derived from a small motor. This motor, through a crank mechanism, lifts the pointer, which descends by gravity upon whichever contact it is over at the time, and one of the three lights is switched on through a three-point relay switch. The connections between the pyrometer, the switch and the lights, and the general arrangement is shown by the diagram, Fig. 13. The current for lighting the signal lamps is made and broken by an auxiliary device and does not flow through the instrument. A high resistor, in series with the circuit connecting with the pyrometer, reduces the current flowing through the contactors to less than 0.07 ampere, which prevents sparking at the contactors. This automatic signaling pyrometer, which is a relatively new development, eliminates the man who, in connection with ordinary installations, is required to read the temperatures at the central pyrometer, and signal to the furnace attendants. This instrument, when provided with a suitable switching mechanism, may be arranged to operate batteries of lights for different furnaces; in fact, it may be connected automatically and successively with twelve different groups of lights, and a similar number of thermo-couples, thus controlling the signals for twelve furnaces.

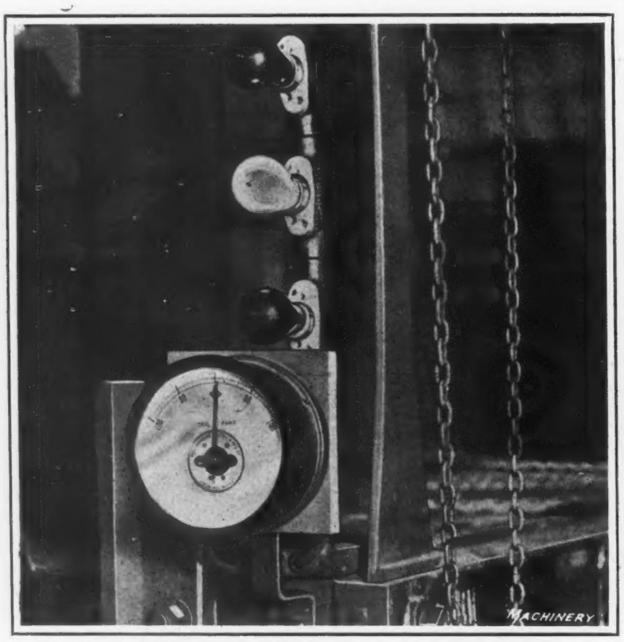


Fig. 16. Detail View of a Deviation Meter and the Three Signal Lights

Automatically Controlled Signal Lights with Deviation Meter at Furnace

The Leeds & Northrup recording pyrometer may be arranged to control signal lights automatically and at the same time produce graphic records of the temperatures. Recording and signaling pyrometers installed at the plant of the Maxwell Motor Co., Inc., are shown in Fig. 14. In connection with this installation, "deviation meters" are used in conjunction with signal lights to show how much the temperatures differ from the correct temperatures. There is a deviation meter and three signal lights for each furnace, and these may be seen by referring to Fig. 15, which shows some of the lead pots of the heat-treating department. The meter and the red, white, and blue lights just above it are also shown by the detail view Fig. 16. The meter scale has a zero position in the center and is calibrated to 100 degrees on each side of this central zero point. The recorder in the central station is set to the temperature

desired, and when this temperature is being maintained, the pointer of the deviation meter is in the zero position and the white light is turned on. If the temperature is 15 degrees too high, this is indicated by the red and white lights, whereas if it is 15 degrees too low, the blue and white lights show. If there is a total deviation of 20 degrees, the red light indicates that the temperature is high and the blue light that it is low, the meter showing constantly just how much the furnace is "off temperature" to the extent of plus or minus 100 degrees. This automatic system simplifies the controlling of temperatures, since the furnace attendants are not required to take readings, and it is simply necessary for them to keep the pointer of the deviation meter in the zero position and the white light burning.

In conjunction with the installation shown in Fig. 14, there is a switchboard which can be operated independently of the automatic or recording instruments. The man seen in the illustration is seated in front of this board, which is simply used for checking the entire system, this double equipment not being necessary. The recorders control all the signaling automatically and independently of this board, but if desired they may be disconnected by means of a switch and the lighting circuit connected with the board.

* * *

POINTS ON JIG AND FIXTURE DESIGN

BY ARTHUR F. OWEN

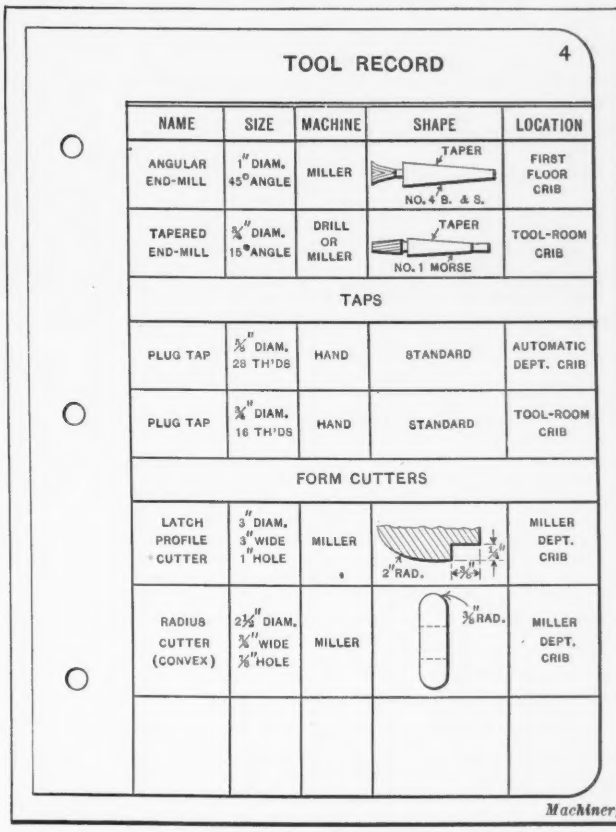
A factor of particular importance in connection with jig and fixture design is absolute unity of purpose and complete understanding between the tool-room foreman and the designing staff. The tool-room foreman should approve of every design that is being worked out, and should furnish tabulated data of special tools and appliances as an assistance to the draftsman in developing the design. This will help greatly in saving time, and often results in the utilization of some special tool that was originally designed for another requirement. When the tool-room foreman presents his specifications as to the jig or fixture required, he may often know of the existence of such special equipment and may have emphasized his idea of the required design while having these things in mind. The draftsman, of course, does not understand the seemingly peculiar characteristics of the required design, and is consequently handicapped.

The designer, having no ready data on the tool-crib contents, or on the capacities of the machine tool equipment, may spend much valuable time in getting this important information—time which under a better arrangement might be utilized in the actual designing work. Frequently a form cutter, for example, made for some special job, will work in just right for milling a cam contour; or the fixture may be made, with a little deviation from the habitual methods of the designer, so that this cutter can be used. The accompanying illustration shows a sample loose-leaf sheet containing data of some of the special tools in the shop and indicating where they are located. If the tool designers were provided with such data in loose-leaf form, much time would be saved and the work would be greatly facilitated.

Often a knowledge of the sizes of bolts and other holding parts kept in stock will enable the draftsman to provide holes of suitable size in the castings so that time may be saved in setting up, or so that suitable lugs or bosses may be attached in order to save making special straps and bolts.

In reference to grinding, tool designers often specify on the drawings that a certain surface of the jig or fixture is to be ground, which in reality requires no grinding. On the other hand, sometimes a surface which is not specified by the designer to be ground is used as a locating surface and should, therefore be ground, both as an insurance of greater accuracy and as an ultimate time-saving precaution. Many times, carburized machine steel jig parts are ground, following the directions of the drawing, whereas the warpage which occurs is so negligible that grinding is not required. In cases of this kind, the advice of the tool-room and of the heat-treating department foremen is needed. No set rule can be made in regard to the factor of heat-treatment as an influence upon such a varied line as jig and fixture parts; however much data can be standardized with respect to the material used.

The use of lapped bushings for reamers and boring-bars should be carefully considered. Sometimes extreme accuracy and a high polish is necessary, but on tools of ½-inch diameter or over, it is seldom that a lapped bushing wears longer or gives more accurate results than an ordinary ground bushing. In this connection it is necessary that the draftsman know the capacities and working limits of accuracy of which the grinding machine is capable.



TOOL RECORD 4

NAME	SIZE	MACHINE	SHAPE	LOCATION
ANGULAR END-MILL	1" DIAM. 45° ANGLE	MILLER	TAPER NO. 4 B. & S.	FIRST FLOOR CRIB
TAPERED END-MILL	⅝" DIAM. 15° ANGLE	DRILL OR MILLER	TAPER NO. 1 MORSE	TOOL-ROOM CRIB
TAPS				
PLUG TAP	⅝" DIAM. 28 TH'DS	HAND	STANDARD	AUTOMATIC DEPT. CRIB
PLUG TAP	¾" DIAM. 16 TH'DS	HAND	STANDARD	TOOL-ROOM CRIB
FORM CUTTERS				
LATCH PROFILE CUTTER	3" DIAM. 3" WIDE 1" HOLE	MILLER	2" RAD. ¼" ⅜"	MILLER DEPT. CRIB
RADIUS CUTTER (CONVEX)	2½" DIAM. ¾" WIDE ⅞" HOLE	MILLER	⅜" RAD.	MILLER DEPT. CRIB

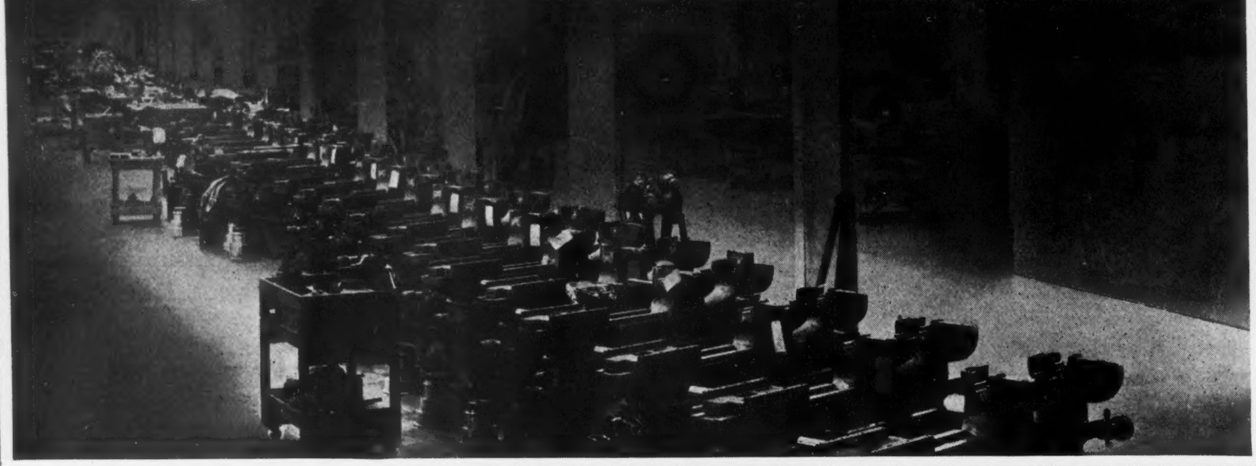
Machinery

Sample of Loose-leaf Data Sheet

The tool tracer, or efficiency man, plays an important part in the efficient design and the production of jigs and fixtures. Working directly under the superintendent, he follows the tooling from the beginning to the end. He watches the design formulate, follows it in its various stages through checker, tool-room, and try-outs, and sees that the jig or other equipment which is delivered to the production department is capable of performing the duties for which it was intended. All tool performances are recorded by the efficiency man, and he is therefore in a position to recommend changes in material and construction where needed. He is especially qualified to understand the importance of complaints and to effect an unbiased settlement of any questions which may arise regarding either the design or the efficiency of the tool. He is not a member of either the shop or the designing department, but works with both, and is therefore regarded as a confidant by both shop and drafting-room. The draftsman knows that the design which he has worked out will receive fair treatment in his hands and the toolmaker looks to him for dependable help and guidance in tooling; thus the amount of experimentation is greatly reduced. The tracer must be an experienced designer and a graduate of the shop, and he should be by nature diplomatic.

Suggestion slips, filled out in the shop and handed to the tool tracer, are a source of help to him generally in recording complaints and proposed improvements. If he cooperates with a tool committee composed of the department heads, many cases of misdirected endeavor are often discovered and consequently remedied.

Principles of Interchangeable Manufacturing



A General Review of the Many Factors that Must be Considered in Connection with Interchangeable Manufacturing, Each of Which Will be Dealt with in Detail in Subsequent Articles

By EARLE BUCKINGHAM, Engineer, Pratt & Whitney Co., Hartford, Conn.

ONE of the greatest reconstruction problems that face American manufacturers consists in meeting European competition while paying, as they must, higher wages than are paid abroad. Yet a higher labor cost does not necessarily mean a higher cost of production. This has been proved time and time again. It does mean, however, that every bit of productive effort must give results commensurate with its cost.

Interchangeable manufacturing, with its opportunities of quantity production at low cost, offers one solution of this problem. Many commodities have long been manufactured on this basis. Yet it is safe to say that there has never been a time when so many concerns were so directly and vitally interested in this problem as at present, when all our thoughts are given to maintaining a low cost of production despite all handicaps. Under these conditions, a review of the basis and methods of interchangeable manufacturing should be of more than academic value to those interested.

Interchangeable manufacturing consists of machining the component parts of a given mechanism in the manufacturing departments within such limits that they may be assembled in the assembling department without fitting or further machining. Component parts may also be replaced or transferred from one mechanism to another without detriment to the functioning and without machining. The advantages of such a method of manufacture are self-evident, and need not be dwelt upon further. It is obvious that with proper equipment and control, the component parts of a mechanism can thus be manufactured in large quantities at a low direct labor cost.

Economy of Interchangeable Manufacturing

In all private industrial enterprises ultimate economy is the controlling factor of any method of procedure. This does not necessarily mean that the methods adopted always are actually the most economical. Methods which will promote this economy are, however, the ideals toward which we are constantly striving. Now, a careful analysis will show that interchangeability does not always result in ultimate economy. In such cases the attempt to maintain it is a fault, not a virtue.

To make this point clear, let us consider the matter first from the standpoint of production alone. The equipment and preparation necessary to produce interchangeable parts are very expensive. If we are making only a small number of special mechanisms, it would be gross extravagance to maintain any high degree of interchangeability. Viewed simply as a question of production, the problem of interchangeable parts is solved by establishing a balance between manufacturing and assembling costs, whether the quantity of production be great or small, whether the mechanism involved be a standard or a special product.

Ultimate economy, however, must include the factor of service. Suppose we sell automobiles, typewriters, sewing machines, or sporting rifles. Parts will wear out or be broken by accident. If we maintain service stations, where extra parts are quickly available, we tend to keep our customers satisfied. Our service stations will be least expensive if our product is truly interchangeable and our agent can replace a part with the aid of a screwdriver or wrench—or, still better, if the customer can

Although many articles treating of various individual phases of interchangeable manufacturing have appeared in the engineering press from time to time, there has been no comprehensive treatise dealing with this subject as a whole. The present series of articles, therefore, is intended to fill this lack in current technical literature. The Pratt & Whitney Co., Hartford, Conn., has been instrumental in furnishing the information contained in this treatise, and submits it to the mechanical world as a part of the company's contribution to the science of interchangeable manufacturing. The writer of the treatise, Major Earle Buckingham, has for more than ten years been in constant touch with many of the complicated manufacturing problems that arise in the production of interchangeable mechanisms in large quantities, and his varied experience during the past four years of war, in the service, first, of private corporations, and later, of the Ordnance Department, has given him a wide outlook and indicated to him that the absence of common methods of interpretation of drawings and of the application of tolerances, gages, and specifications, presents an urgent need for a complete treatise on a subject which is of so much interest to manufacturers.

replace it himself. Since the advent of the automobile, people have been much more interested in things mechanical than before, and have taken pride in making their own repairs. The more nearly interchangeable we make our mechanisms, the more we foster this desirable trait and the less our service stations will cost. Ultimate economy, then, requires that our service costs be balanced against our total productive costs.

Degree of Interchangeability Desirable

It should not be assumed from this that we must have entire interchangeability or none at all. In almost every mechanism certain parts are begun as separate units in order to simplify the manufacture, but are later permanently assembled into a single unit and machined to completion as such. In many such cases, the expense of attaining interchangeability would be so great, because of the many mechanical difficulties to be overcome, that we would not be justified in attempting it. It would be more economical, in case of breakage, to discard and replace the entire assembled unit. In other cases, the functional requirements may be so severe that a system of selective assembly will prove to be the proper course, although this entails carrying a double or triple number of spare parts in service stations, or involves some fitting when replacing unserviceable parts.

In general, however, interchangeability is a desirable goal, and is readily attained in the majority of cases if the proper attention is given to the basic principles governing it, including the design of the mechanism and the process of manufacture; yet it is limited in several directions by the inadequacy of many of our present manufacturing conditions. With improved facilities, it may be that in future years a much greater degree of interchangeability will be possible than at present.

The following paragraphs, which are based on manufacturing conditions as they now exist, trace the progress of a commodity through all stages of its manufacture, from its inception as a mechanical project to the final testing that determines its successful completion, and attempt to single out for special comment, those factors which make possible, or promote, the interchangeable manufacture of its parts.

The general tendency in the past has been to establish manufacturing tolerances by trying to hold the product as closely as possible to a fixed size. The natural result of this policy has been that the tolerances established on paper are often exceeded; yet the actual working variations remain unrecorded, because it is argued that under certain conditions the original requirements might be met and therefore the tolerances noted are the proper ones even though they are not maintained. Every effort to make the recorded tolerances represent the actual working tolerances is opposed on the grounds that such a procedure would lower the shop standards. As a matter of fact, it is hard to understand how anything could lower the standards of the shop more than to permit the workmen to disregard absolutely the rules which they are supposed to be following.

The Design as it Affects Success in Interchangeable Manufacturing

The development of any new mechanism starts with a mental conception of some function to be performed. This conception then takes detailed form, first mentally, then on paper, and finally in metal. The experimental model—if such be constructed—is usually made by the cut-and-try method. Little attention is paid in the beginning to future manufacturing requirements. The main object is to construct a mechanism that will function properly regardless of the exact design. When this end is reached, what we may call the inventive or functional design has demonstrated its success.

We are not yet ready to begin manufacturing. We must first perfect a manufacturing design, which will so modify the inventive design as to allow its economical production on a large scale. Several manufacturers recognize this twofold nature of designing, and maintain a separate department for each type. Indispensable as is the original invention, it is the manufacturing design which largely determines the success or failure of a given project. This manufacturing designing necessarily continues throughout the whole course of production because of the almost infinite number of petty detailed questions involved, only a few of which can be foreseen and answered in advance. One of the important functions of an engineering department is to keep in close touch with the progress of the work in the shops, deduce general principles therefrom, and apply these principles not only to the work in hand, but also to all new work that may be developed.

The Manufacturing Model

We will assume that the functional requirements of the mechanism are established and that the manufacturing design has been adopted. Our first concern is to test this design as far as possible. The most certain method of accomplishing this is to develop a physical model. Such a model must not be confused with the experimental model, as its purpose is quite different. The experimental model convinces us that our mechanism will perform certain functions. The manufacturing or physical model, if properly developed, proves that our mechanism, as modified and developed to facilitate manufacture, still retains the functional advantages of the experimental model. The manufacturing model is naturally an expensive piece of equipment, but if a large output of a new commodity is under consideration, it is money well invested. In the case of a small total output, a "pilot" mechanism is often built for this purpose, which is not set aside for future reference but incorporated in the product itself.

There are many other services which a manufacturing model is capable of rendering. It may serve as a physical standard of dimensions for the future product. In this case, it must be made with much greater care than if it were to be used merely to test the functioning of the manufacturing design. Such a model will be of great value as a reference at all times during production. In itself, it comprises an effective functional gage to test any completed part. It should be used but rarely, however, for that purpose. In addition, the component parts of the model are of great assistance in checking the manufacturing equipment in the early stages of the work.

Clearances—the Vital Factors in Interchangeable Manufacturing

Clearances are vital factors in interchangeable manufacturing. Fits can be secured without interchangeability, but the latter cannot be maintained without proper clearances. It is self-evident that a certain space must be left between operating parts. The minimum clearances should be as small as the assembling of the parts and their proper operation under service conditions will allow. The maximum clearances should be as great as the functioning of the mechanism permits. The variation between a maximum and a minimum clearance determines the manufacturing tolerance. It is clear, then, that if we determine at the outset the permissible clearances we shall have established also the extent of the tolerances which control the final inspection.

Clearances should be one of the principal considerations in developing the manufacturing design. This design should aim to allow the greatest possible amount of clearance between companion parts. The more the design lends itself to this end, the greater the economy of manufacture and the greater the degree of interchangeability obtainable. In determining which parts of a mechanism can be made interchangeable, this matter of permissible clearances plays the largest part. A mechanism which is so designed that it cannot permit fairly liberal clearances is not a suitable one to

be manufactured on a strictly interchangeable basis with the standard equipment now available. Every operating part of a mechanism must be located within reasonably close clearances in each plane. After such requirements of location are met, all other surfaces should have liberal clearances, unless the factor of strength is the controlling one.

Manufacturing Tolerances

The general tendency in the past has been to establish manufacturing tolerances by trying to hold the product as closely as possible to a fixed size. The natural result of this policy is that the tolerances established on paper are often exceeded; yet the actual working variations remain unrecorded, because it is argued that under certain conditions the original requirements might be met and, therefore, the tolerances noted are the proper ones, even though they are not maintained. Every effort to make the recorded tolerances represent the actual working tolerances is opposed on the ground that such a procedure would lower the shop standards. As a matter of fact, it is hard to understand how anything could lower the standards of the shop more than the absolute disregard of the rules it is supposed to be obeying.

There is a further argument for the acceptance of liberal tolerances. Too often in manufacturing concerns, and especially in the case of interchangeable manufacturing, one finds details being made ends in themselves rather than means to a larger end. In producing a component part, it is not our main object to demonstrate how closely we can make it approach a fixed size; our aim is to construct, as economically as possible, a mechanism that will satisfactorily perform certain functions. The knowledge of how accurately a machining operation can be performed is indeed invaluable in making our manufacturing design; but when that design has once been completed, our interest shifts to the proper functioning of the completed mechanism. Finally, it may be said that in most cases the tolerances originally fixed are increased during the process of manufacturing without detriment to the mechanism. It is rarely that a tolerance has to be reduced.

Gages should be provided only when their use will prove more economical than the use of standard measuring instruments. When the total production amounts only to a small number of units it is uneconomical to provide special gages. The extent to which gages are necessary, therefore, depends in a great measure on the amount of the total production. Furthermore, gages should be provided to check only those conditions which it is essential to maintain. In many cases a check on one or two points is sufficient to detect errors. Gages are a preventive and not a cure. The point to be emphasized is that they should be provided whenever their use will result in the production of more or better work with an expenditure of the same or less effort.

The proper minimum clearances can be determined quite readily and definitely for most cases in the early stages of the work—the manufacturing model is of great value in this respect—but the maximum clearances become established only after extended experience with the particular mechanism. In many cases the extreme maximum is never found, because long before that point is reached, the tolerances have become so liberal that there is no need, from the standpoint of economical production, to increase them further.

Component Drawings

Component drawings have two main functions to perform. The first is to give such information about the design and the tolerances that the manufacture of the product can begin. This does not seem like a very difficult task, but the notation of the tolerances on component drawings has created new problems of interpretation that have not, as yet, been fully solved. At the present time, the language of drawings is not altogether clear and exact.

The first tendency in introducing tolerances on drawings seems to have been to attempt to express a permissible variation on every dimension given. The results obtained in the shop depend, then upon the particular combination of dimensions used. Different organizations using different combinations could obtain radically differents results; and of the possible number of different combinations there is no end.

The existence of a tolerance on a drawing is an acknowledgment that variations are inevitable in the physical dimensions of the product. Any dimension given on such a drawing without a tolerance should not be construed to denote an absolute size without error, but rather to indicate either that the permissible variation for that point or surface is controlled by tolerances given on other co-related dimensions, or that the dimension is so relatively unimportant that no attempt had been made to determine its permissible variation.

In making component drawings, the effort should be made to so give the dimensions and necessary tolerances that it would be possible to lay out one, and only one, representation of the "maximum metal" condition and one, and only one, "minimum metal" condition. If such lay-outs were superimposed, the difference between them would represent the permissible variation on every surface. Any condition of the product which fell within the zone thus established could be considered as meeting the requirements of the drawing. If one will make a few such lay-outs, it will soon be clear to him that there are always a number of dimensions that should be given without tolerances if we desire to keep our drawings consistent and intelligible.

Information Recorded on Component Drawings

It must be realized at the start that it is impossible in every case to give on one component drawing all the dimensions that are needed to construct the patterns, tools, gages, and other manufacturing equipment, without introducing many inconsistencies. Certain dimensions could be correct if one set of holding points and one series of operations were to be used, but would be incorrect under different conditions. If the component drawings are made so that they represent the proper completed conditions—call them inspection gage requirements if you will—the end in view is attained. Any figures that the shop desires to use are correct if they insure this result.

It is impossible to amplify this point without entering into a prolonged discussion of the effect of using different holding or registering points in the manufacturing processes. Yet it may be of interest to know that several manufacturing plants solve this problem by adding operation drawings, which give only the specific dimensions required at a particular operation. Some of the dimensions are duplicates of those on the component drawing, while others are computed to serve their restricted purpose. This proves an effective means of recording additional information required in the manufacturing departments, which cannot be put on component drawings without danger of misuse.

After production is well under way, the component drawings have served their first purpose. In the meantime, the actual manufacturing operations have made available a store of new information regarding the proper conditions to be maintained. It should be the second function of the component drawings to record as much of this information as possible. Conflicting information or misinformation should be eliminated at the same time; in short, the drawings should be revised to agree with actual conditions and requirements. It has been our great fault in the past to neglect this second function almost entirely. It is a difficult task to make the component drawings represent from the first conditions that must be maintained. In time, the shop will discover many of them, often after bitter experience, even though they have been omitted from the component

drawings. Frequently, however, it happens that this information does not make its way back to the office, but is retained by the shop men among themselves. Often this is the fault of the office, which is prone to consider such information as criticism, so that the shop, after a few rebuffs, makes no further attempt to pass it along. It is most essential, however, that such information be recorded in permanent form, not only because of its value to the work in hand, but also because of its helpful application to new work in the future.

Dimensioning of Component Drawings

The problem of the proper dimensioning of component drawings is strictly a mathematical one. There are a few basic principles in regard to it which are as fixed and simple as Newton's three laws of motion, but are even more difficult at times to apply correctly. Whenever either of the two following principles is violated, trouble will inevitably follow:

(1) In interchangeable manufacturing, there is but one dimension (or group of dimensions) in the same straight line that can be controlled within fixed tolerances. That is the distance between the cutting surface of the tool and the locating or registering surface of the part being machined. Hence, it is incorrect to locate any point or surface with tolerances from more than one point in the same straight line.

(2) Dimensions should be given between those points which it is essential to hold in a specific relation to each other. The majority of dimensions, however, are relatively unimportant in this respect. It is good practice to establish locating points in each plane, and to give, as far as possible, all such dimensions from these common locating points.

One of the main functions to be performed by a drawing is to give such information about the design and the tolerances that the manufacture of the product can begin in the shop. This does not seem like a very difficult task, but the notation of tolerances on drawings has created new problems of interpretation that have not as yet been fully solved. At the present time, the language of drawings is not altogether clear and exact. An attempt is often made to express a permissible variation on every dimension given. The results obtained in the shop depend, then, upon the particular combination of dimensions used. When different combinations are used, radically different results may be obtained, and the problem that at first appears simple will be found upon further consideration to require profound study.

There are also a few other general principles which it is good practice to follow. Although violations of them are not errors in themselves, they lead to many unnecessary errors. In all of this work we must realize that we cannot create anything that is altogether fool-proof; the best we can hope to accomplish is to make conditions such that little or no excuse remains for making a mistake. The three following principles are of this order:

(1) The basic dimensions given on component drawings for interchangeable parts should be the maximum metal sizes, except for force fits and other unusual conditions. The direct comparison of the basic sizes should check the "danger zone" or the minimum clearance conditions in most cases. It is evident that these sizes are the most important ones, as they control the interchangeability. They should be the first determined and, once established, they should remain fixed if the mechanism functions properly and the design is unchanged. The direction of the tolerances, then, would be such as would increase this clearance. For force fits, such as taper keys, etc., the basic dimensions should be those which determine the minimum interference (which is the "danger zone" in this case) and the direction of the tolerances for this class of work should be such as would increase this interference.

(2) Dimensions should not be duplicated between the same points. The duplication of dimensions causes much needless trouble, due to changes being made in one place and not in the others. It causes less trouble to search a drawing to find dimensions than it does to have them duplicated and, though more readily found, inconsistent.

(3) As far as possible, the dimensions on companion parts should be given from the same relative locations. This procedure assists in detecting interferences and other improper conditions.

If careful thought is given to these component drawings, much time and effort will be saved later in the shop. If they are neglected, all the future work will suffer. A large percentage of the mistakes made in the manufacturing departments may be traced back to improper component drawings.

Specifications for Interchangeable Manufacturing

The information that can be included on component drawings, except in the case of a very simple or familiar mechanism, is seldom sufficient in itself to enable the manufacturer to proceed intelligently with a new product. It is very desirable that he know the particular purpose for which the mechanism is to be made. The better he is informed on this subject, the greater service he can render in promoting its economical manufacture and future development. Specifications are supposed to supplement the drawings by giving all the needed additional information which has no place on the drawings. I say "supposed" because it is only in rare cases that the specifications commonly met with give all the desirable information. They usually deal with only the most exacting requirements and make no mention of the others, thus establishing a severe precedent for the solution of all questions in regard to the requirements, important and unimportant. They seldom indicate the essential object in view, namely, the economical production of mechanisms which will function satisfactorily.

Specifications should state the end to be accomplished, and should give all possible information to assist in the attaining of that end. Any unusual conditions should be explained in detail. All exacting requirements should be specified with the reasons for the same, including requirements of functioning and of materials to be used. But they should not stop here. The less exacting conditions should be noted also. If a certain material is specified, and the chief consideration is economy, it should be so stated, with the substitution allowed. The material that might be most economical under one set of conditions might be otherwise under different circumstances. Parts which are detailed on the drawings but for which commercial articles can be substituted should be so designated. The specifications should list those parts which must be made interchangeable and those which need not be. A description of the tests for materials, for physical dimensions, and for functioning should be included. In fact, any information that will assist in the manufacture of the product should be given. Some of it will specify the results to be obtained; more of it should be information to assist the manufacturer, not hard and fast rules which he must follow regardless of consequences.

Such specifications would undoubtedly be far from complete at first. Provision should be made to keep them abreast of the actual progress of the work. The shop should use them as a place to record as much of the experience gained as possible. If certain methods have been found unsatisfactory, here is an ideal place to record the fact, and perhaps save a duplication of the mistake in the future. If other methods have proved satisfactory, they, too, should by all means be recorded. In fact, specifications of this kind, although they would in time become voluminous, would be a history of a mechanism and furnish valuable data to assist in developing new mechanisms.

Written specifications are held in low esteem by the majority of manufacturers. They do without written specifica-

tions for their own products, and when obliged to meet them for contract work, find them an additional annoyance instead of a help. This is due, in a large measure, to the fact that this subject, as also the matter of tolerances, has been regarded as an end in itself instead of as a means to a larger end. Manufacturers do have specifications, although they are seldom called by that name and are seldom written or grouped together for ready reference. Some of them may be found in the cost and production records, some in the shop correspondence, but most of them are carried in the memories of the foremen and older employes who maintain the traditions of the shop.

A rigid adherence to the letter but not to the spirit of the drawings and specifications is unwise, as it will not aid in the acceptance of all serviceable material nor in the ultimate economy of manufacture. Inspectors must have a certain amount of education and experience with the mechanisms involved or with similar mechanisms; otherwise the inspection will always prove a hindrance to the main purpose.

Gages as a Necessary Means for Checking Results Obtained

Thus far we have been discussing those elements which form the groundwork for our actual manufacturing operations. We have developed our manufacturing design, have tested it with our manufacturing model, have made the first guess as to the proper manufacturing tolerances, have recorded all suitable and available information on our component drawings, and have partially developed the specifications to supplement these drawings by recording there all further information available that will assist us to accomplish our main purpose, namely, to produce satisfactory mechanisms as economically as possible. We must now consider the means of carrying on the work of actual production and the facilities that should be provided for checking the results.

There are two important reasons for inspecting the product during manufacture: First, spoiled parts must be eliminated as soon as possible to save the expenditure of useless effort on unserviceable pieces. Second, the completed components must be checked before assembly to eliminate the unserviceable parts and thus insure the proper functioning of the mechanism. For these purposes, gages are extensively employed.

A gage should be provided whenever its use is more economical than the use of standard measuring instruments. For example, if the total production of a certain mechanism amounts to about a dozen units, it is gross extravagance to provide special gages. On the other hand, if this production amounts to several thousand units, a complete set of gages is both desirable and necessary. The extent to which gages are necessary, therefore, depends in great measure upon the amount of the total production. Furthermore, gages should be provided to check only those conditions which it is essential to maintain. The nature and extent of the gages required depend upon the manufacturing conditions. In many cases, a check on one or two points is sufficient to detect any unsatisfactory results. Under varying manufacturing conditions different faults must be guarded against. Gages are a preventive and not a cure. The point to be emphasized is that they should be provided whenever their addition will result in the production of more or better components with a total expenditure of the same or less effort.

Main Classes of Gages

There are two kinds of gages to consider, which, for want of better terms, we will call limit gages and functional gages. A limit gage is one that checks a specified dimension to specified tolerances. A functional gage is one that checks the relationship of several dimensions to insure the proper functioning of the assembled mechanism. As with all other manufacturing equipment, the exact design of a gage is unimportant, provided that it fulfills its purpose in a simple and efficient manner.

The operator should be taught to maintain the established tolerances. If the specified tolerances prove too severe in practice for economical production, they should be corrected, provided the functional requirements of the mechanism will permit. If they are not too severe, there is no excuse for not adhering to them. The practice of insisting upon the operator's adhering to the specified tolerances will aid a great deal in producing a high quality of work.

The degree of accuracy or precision required depends upon the extent of the tolerances. In all cases, on limit gages, the variation must be inside the established limits of the component. The dimensions given on component drawings are limit gage sizes. For example, the limits given for the diameter of a stud should be interpreted to mean that such diameter must be made to satisfy ring or snap gages of the sizes specified.

As yet we have not touched upon master gages, or reference gages, as they are variously called. A master is a physical standard of size or form used for reference purposes. It is needed only where the degree of precision required is so exacting that the errors which are inherent in direct measurements with standard measuring instruments will be great enough to prevent the proper functioning of the product. If a manufacturing model is carefully developed, few, if any, masters will be required. For simple dimensions of length, it is usually sufficient to establish reference pieces of, say, tenth-inch units. For important functional contours, masters are essential.

Test pieces for individual gages are necessary only when the amount of gage checking is so great that too much time is consumed by using standard measuring instruments, or when no skilled labor is available for this checking. Test pieces are therefore desirable for checking complicated profile and fixture gages that receive hard usage, but they are seldom necessary for plain plug, ring, and snap gages.

Manufacturing Equipment

We must also provide suitable tools and equipment with which to manufacture our product. The first logical step to this end is to make operation lists, planning in detail the successive operations, and specifying the type of machine, fixture, tool, and gage required. These operation lists are an integral part of the specifications, subject, of course, to such modifications as are found necessary. Of the machines themselves we need make but little mention at this time. Standard machine tools are now on the market for making almost every variety of machining cut. Special machines are required only for very unusual operations or for extremely large productions where many automatic operations are performed.

The design of the fixture and the tool depends to a great extent upon the design of the piece to be machined. Great care should be taken to maintain the same locating or registering points in the fixtures as are used for the gages. The ideal condition is to have the registering points both for fixtures and gages identical with the points on the component drawings from which the surfaces in question are dimensioned. After the equipment is complete, the component drawings should be checked and revised where necessary to obtain this result.

Another factor which must be considered in the design of the equipment is the required rate of production. In the case of a small output, the cost of the equipment amounts to a large percentage of the total cost of production. As the output increases, the proportionate cost of the equipment decreases, thus making it desirable to refine this equipment, if by so doing the production can be increased with the expenditure of less productive effort. Here, as elsewhere,

it is a question of balancing the cost of one item against that of another and of selecting the most economical combination.

In most cases, except with some automatic machines or on very large work, the operator spends more time in handling the work than the machine takes to perform the machining operation. Therefore, whenever the rate of production is high enough to make it economical, the fixtures should be made so that they can be operated rapidly, even though this greatly increases the initial cost of the equipment.

Production Problems as Related to Interchangeable Manufacturing

The actual production consist of taking the raw material and passing it through the equipment until it emerges as a finished component. The production problems are many and varied. Any part of the preceding work which has been slighted or left undone must be completed here in addition to the many tasks which are involved in the production itself. The greatest problem involved in production is that most uncertain factor—human nature. The present tendency is to provide equipment that can be operated by semi-skilled labor. We must realize, however, that we cannot make our equipment altogether fool-proof. As noted before, we can only arrange matters so that little or no excuse remains for making mistakes.

We thoughtlessly speak of unskilled labor. The more this problem is studied, the more we realize that there is no place in interchangeable manufacturing for such assistance. That is, there is no task so elementary but that better and more economical results can be obtained by a certain degree of training or skill in the operator. We try to subdivide our productive operations into the most elementary tasks so that our labor can be readily trained to perform them satisfactorily. Each manufacturer is forced to train the majority of his own operators. Naturally, then, the shorter the time required for this training, the sooner the results will show in the production. On the other hand, the less skill required of the operator, the more elaborate and complete the equipment must be. The amount of supervision required for both operators and equipment is also greatly increased, both in quantity and quality.

In any case, the better the training that these operators receive, the higher is the quality of the work produced. And the matter of honest, serviceable quality as distinguished from mere appearance is more appreciated than formerly. The operator should be taught to maintain the established tolerances. If the specified tolerances prove too severe in practice for economical production, they should be corrected, provided the functional requirements of the mechanism will permit. If they are not too severe, there is no excuse for violating them. The practice of adhering to the specified tolerances will do much to promote a high quality of product.

Inspection of Product while Work is in Progress

The inspection and acceptance or rejection of the components falls logically into two divisions. The first is the shop inspection which is made while the material is in process of manufacture. The object is to cull out defective work as soon as possible and also to detect any defects in the equipment that would result in faulty work. If the percentage of rejections is normal, it is evident that the requirements specified and the manufacturing facilities provided are satisfactory. If the percentage is high, it is evidence of improper conditions somewhere which should be investigated, and the trouble should be corrected at its source. Sometimes an error occurs, with the result that the requirements are exceeded on a large number of parts. Such matters should be investigated and settled according to their merits. If the pieces will be serviceable and can be completed without undue cost, the factor of economy will play a large part in the decision. In such cases, the requirements specified should not be changed unless it is evident that such a change will result in an economic benefit in the future. As in all other cases, ultimate economy is our goal.

Final Inspection

The second division of the inspection is the final examination of the completed parts. The object of this inspection is to see that all components which will function properly are accepted and that all unserviceable parts are rejected. This inspection is largely governed by the requirements of the component drawings—often represented by gages—and by the specifications. It is therefore most important that the drawings and specifications give as nearly as possible the limits of parts which will function properly. Yet we have already seen that these drawings and specifications are incomplete at the beginning, and probably will always be so, to a certain extent. Therefore, a rigid adherence to the letter but not to the spirit of the drawings and specifications is unwise, as it will not aid in the acceptance of all serviceable material, nor in the ultimate economy of manufacture. In addition to the written requirements, inspectors must have a certain amount of education and experience with the mechanisms involved, or with similar mechanisms; otherwise the inspection will always prove a hindrance to the main purpose.

The characteristic needed for a successful inspector is a judicial mind. Since the requirements are laws, the inspection should equitably enforce them. The spirit of the requirements should be enforced in those cases where their exact expression is incomplete. If the essentials are always specified definitely and completely, it will be a fair assumption that incompletely specified conditions are relatively unimportant. Wherever possible, the requirements should be revised to make the letter and the spirit agree, but the attempt to cover every minute and unimportant detail will prove impossible in practice.

The functional requirements should be maintained in the final inspection strictly according to the specified conditions. The non-functional requirements should be handled in a more judicial manner, each case being decided on its merits. As a matter of fact, this final inspection should be in the nature of a functional inspection only. Little attention should be given here to the non-essentials other than, perhaps, a visual inspection for general quality, and some supervision of the shop inspection to see that proper precautions are taken during production to insure a good product. In all cases, the main effort throughout the work should be to establish, define, and maintain the essential conditions first, letting the non-essentials develop in practice. No secret, however, should be made of the fact that these non-essentials are left to work out their own salvation.

The final and complete evidence as to whether or not we have accomplished our purpose is furnished after we have assembled and tested our mechanisms. If the total costs have been reasonable and the completed mechanisms assemble properly and perform satisfactorily all the required functions, it is conclusive evidence that we have mastered all essentials. On the other hand, if the costs are excessive or if the mechanism fails to assemble or to operate properly after being assembled, it is equally conclusive evidence of failure.

* * *

The U. S. battleship *Idaho* is the largest American war craft afloat. The principal dimensions of the vessel are as follows: Length, 634 feet 6 inches; beam, 97 feet 4½ inches; mean draft, 30 feet. The loaded displacement is 34,000 tons, and the armament consists of twelve 14-inch 50-caliber guns, arranged in four turrets, of three each, while the secondary battery consists of twenty-two 5-inch guns. In addition it is fitted with 21-inch torpedo tubes, and numerous small rapid-fire guns, including four 3-inch anti-aircraft guns. Including armor plate and guns, the total cost of the craft is about $18,000,000. The motive power is furnished by Parsons geared turbines, having a total of 32,000 horsepower, which will give the ship a speed of twenty-one knots. The *Idaho* is oil-burning, and the steam is produced by a battery of twelve boilers.

Fig. 1. Pouring Kinite into the Molds

The Making of Kinite Dies

A NEW material known as "kinite," for use in making blanking, trimming, and forming dies, as well as other tools, has recently been introduced by the Kinite Co., Milwaukee, Wis. This material consists of an alloy steel containing chromium and cobalt, but no tungsten, and has been found especially adapted for making dies requiring great resistance to abrasion or wear. Trimming dies for hot forgings, for example, are among the tools for which the material is well suited. Furthermore, the material is practically non-corrosive, and has been found excellent for the making of glass and other molds requiring a high heat-resisting material.

Molding Kinite Dies

The illustrations Figs. 1, 3, and 4 show views in the Kinite Co.'s foundry, illustrating the methods used in producing kinite dies. The basic raw material used is made in the electric furnace. The pigs, or ingots, are then remelted in crucible furnaces and are cast in specially prepared hard molds which are made very close to the finished size of the required blank for the tool. The molds are made 2 per cent larger than the finished size of the tools to be made, this allowance taking care of both the machining allowance and the reduction of the casting when cooling in the mold. The castings, as they come from the molds, have the appearance of forgings rather than castings. The material is melted at a temperature of practically 3000 degrees F., and is poured at nearly that temperature.

The molds are made from special sand mixtures that will resist the high heat of the kinite steel when poured, and after being made, the molds are baked in an oven, shown in Fig. 3, until they are very hard. For solid bars made from kinite, so-called "permanent" or "chill" molds are used, these molds themselves being made from kinite.

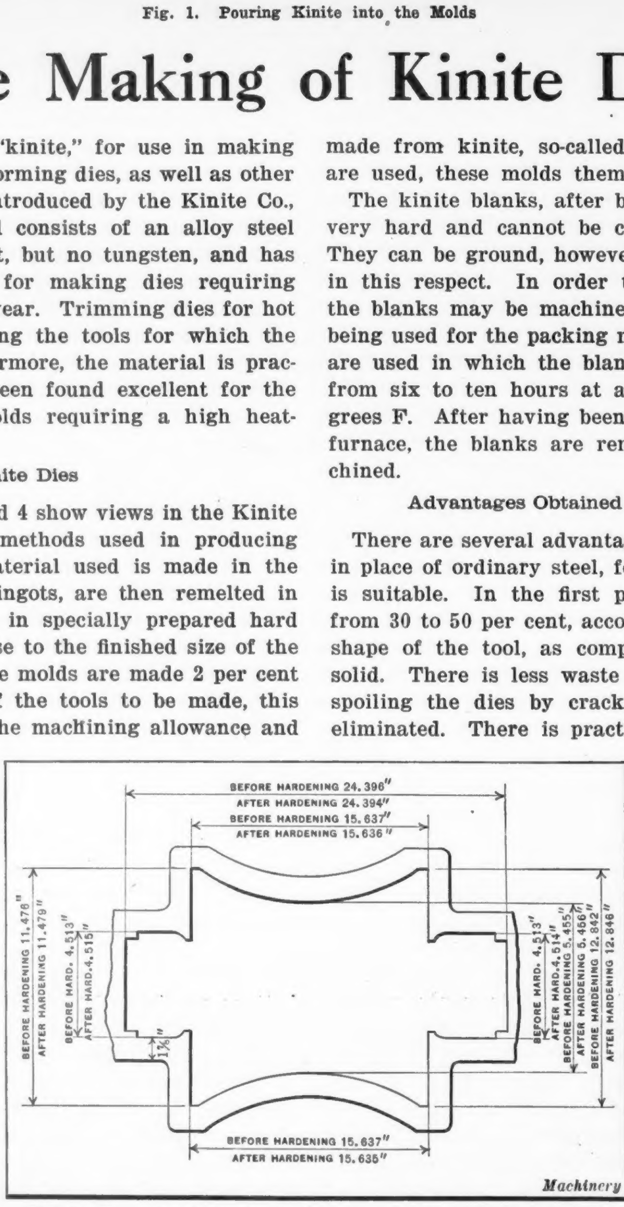


Fig. 2. Example of the Small Change produced in hardening Kinite

The kinite blanks, after being taken from the molds, are very hard and cannot be cut by any ordinary steel tools. They can be ground, however, and are like manganese steel in this respect. In order to reduce the hardness so that the blanks may be machined, they are pack-annealed, sand being used for the packing material. In annealing, furnaces are used in which the blanks are permitted to remain for from six to ten hours at a temperature of about 1900 degrees F. After having been permitted to cool slowly in the furnace, the blanks are removed and are ready to be machined.

Advantages Obtained by the Use of Kinite Tools

There are several advantages obtained by the use of kinite in place of ordinary steel, for the purposes for which kinite is suitable. In the first place, the machining is reduced from 30 to 50 per cent, according to the design and peculiar shape of the tool, as compared with dies made from the solid. There is less waste of material, and the danger of spoiling the dies by cracking in hardening is practically eliminated. There is practically no contraction in hardening, and the ordinary precautions necessary when hardening steel tools are not required. Different dies require somewhat different treatment in hardening, and the makers of kinite prefer to specify the exact hardening temperatures to be used for different classes of work, in order to insure that in every individual case the dies will be properly hardened. The temperature range for hardening varies from 1550 to 1840 degrees F. The tools should be heated slowly and should then soak for some time at

the hardening heat, after which they are taken from the furnace and left to cool in air free from draft. No drawing of the temper is required; the material will be found hard and tough, and without scale. But it has been found by experiment that by drawing the temper at a temperature even as high as 1000 degrees F., the toughness is greatly increased without appreciably decreasing the scleroscopic hardness. As an instance of the slight change that takes place in hardening, the example in Fig. 2 is shown, which gives all the dimensions of a die made from kinite before and after hardening.

When Kinite Ought to be Used

Kinite is recommended by the makers as a material for dies when a large number of pieces are required from the same dies, because of the long wearing qualities of the material. It is stated, as compared with carbon steel dies, from 15 to 20 times the same number of blanks may be obtained between grindings under favorable conditions, and that at least from 10 to 12 times is a conservative estimate. Kinite blanking dies have proved especially advantageous on work made from stock 1/32 inch thick and upward. Drawing dies are also advantageously made from this material, because of the slight wear that takes place in the die when in service.

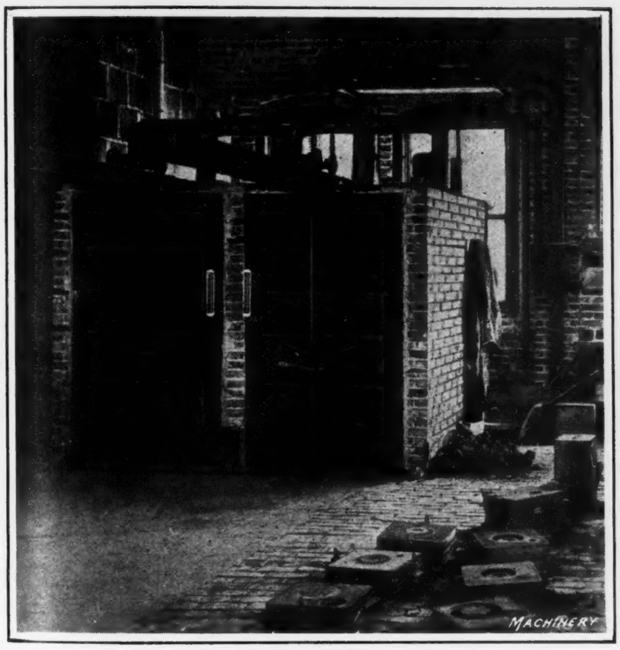


Fig. 3. Oven for drying the Molds

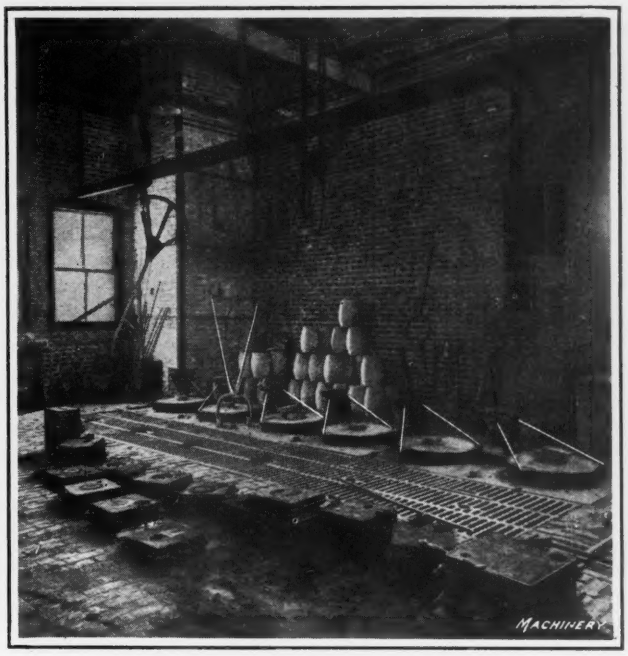


Fig. 4. General View in Kinite Foundry

Recently, glass molds have also been made from kinite. The material has proved suitable for this purpose because glass shrinks more than kinite in cooling, so that the objects made will come loose in the mold. They will also be perfectly smooth, as there is nothing in the mold to stick to the glass. Celluloid and similar materials have also been made in kinite molds to advantage.

The tensile strength of the annealed cast kinite blank is from 45,000 to 55,000 pounds per square inch of section, and the scleroscopic hardness, after hardening, will vary from 75 to 95, according to the results required.

Cost of Kinite Steel Tools Compared with the Cost of Ordinary Steel Tools

The cost per pound of kinite is higher than the cost of high-speed steel, but the reduction in machining cost is so great that most dies can be made more cheaply from kinite than from high-speed steel. The reduced risk in hardening also lessens the first cost of kinite dies, as failures in hardening seldom if ever occur. Where only a small number of parts are to be made from a pair of dies, however, it is evident that it will not pay to make intricate patterns and molds, and in that case it may be cheaper to machine a pair of dies directly from a less expensive grade of steel. All cases must be studied on their merits and a comparison of all factors involved must be made, in order to determine the saving resulting from the use of kinite dies. E. O.

* * *

CHARACTERISTICS OF CHROME-NICKEL STEEL

The writer has noted with considerable interest the article entitled "Characteristics of Chromium-Nickel Steel" on page 913 of the June number of MACHINERY. The article is rather an arraignment of chrome-nickel steels as a class, when, as a matter of fact, the remarks apply to, at the most, two of the higher chrome-nickel types. Great care is required in refining any high-grade alloy steel in order to secure clean metal, and extra pains in rolling and forging well repay the expense of this care in the resultant product. None of the alloy steels will weld, and all of them are likely to develop laps, seams, and cold shuts if improperly handled. The statement that chrome-vanadium steel will machine at a Brinell hardness of 321 as freely as chrome-nickel of the same carbon content which has a Brinell hardness of 241 is not borne out by the facts. At a meeting of the American Gear Manufacturers Association in Cleveland, several gear makers testified that they found chrome-vanadium steel more difficult to machine than chrome-nickel steel. The inference to be drawn from the article is that chrome-nickel steels as a class require more care all the way through in the handling of the metal, and also are machined with greater difficulty than chrome-vanadium steels. This inference is not borne out by the experience of a great many consumers of chrome-nickel steel who prefer it to chrome-vanadium.

Reading, Pa. THE CARPENTER STEEL CO.
J. H. PARKER, Vice-president and Metallurgist

* * *

The Bureau of Mines recently investigated the properties of aluminum dust with special regard to inflammability. It reports that aluminum dust burns quietly when in a pile, but if this burning pile is disturbed in such a manner as to raise a cloud of the dust, the burning takes place with explosive violence. Also, if a dust cloud already formed and having a density within the explosive limits is ignited, a violent explosion results. When the dust starts to burn and water is added to the mass, hydrogen will be liberated and an explosion will result.

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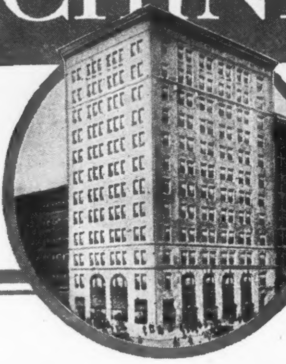

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BASING MANUFACTURING PRACTICE ON ESTABLISHED FACTS

A comparison of present-day manufacturing practice with the methods employed in earlier days of the machine-building industry shows that the difference is not altogether the result of using new and improved types of machines or materials. When light, slow-moving machine tools were replaced by powerful designs and equipped with high-speed steel cutting tools, it was a foregone conclusion that the machine shop had begun a decided forward movement. This advancement has been due not only to improved tool equipment and materials, but to the adoption of methods based on established facts instead of upon the experience of individuals in an organization.

The article in this number, on "Temperature Indicating and Controlling Systems," deals with apparatus which is largely intended to place the heat-treatment of steel on a scientific basis instead of operating such an important branch of mechanical work solely according to the judgment and experience of workmen. The modern idea in manufacturing enterprises is first to decide what is the best practice as far as this can be determined by actual tests and performance, which enables the manufacturer to establish the practical means of applying, without variation, whatever methods have been standardized. In the heat-treatment of steel, as in many other manufacturing processes, uniformity is vital. When correct temperatures for hardening or tempering have been determined, it is essential to maintain them from day to day, and with this end in view the pyrometer manufacturers have developed some very effective apparatus. These different forms of mechanically and electrically operated instruments for regulating temperatures according to what is definitely known about heat-treating processes, are a practical illustration of the constant trend in industrial organizations away from what someone *thinks* is right to what has been *proved* to be right.

* * *

A NEEDED IMPROVEMENT IN MECHANICAL BOOKS

Users of mechanical books frequently discover that they lack many valuable essentials, and this is especially the case with books containing mathematical formulas relating to design. Records of engineering experience are often so written that engineers who are more or less familiar with the subject have been unable to obtain any real information from them. Many engineering books lack numerical examples to show the proper application of the formulas, and they also lack explicit explanations of the meaning of letters and symbols used to denote lengths, weights, or other quantities. Writers of technical articles, especially those involving formulas for the design of machinery or structures, should make it a rule to illustrate every formula given with an example showing exactly how the formula is used. They should also be careful never to use a symbol in a formula unless the meaning of the symbol has been plainly stated. In some instances writers of technical text-books use the symbols in one place only, and then continue in the remainder of the book to employ formulas in which these symbols are used. This practice should be discouraged. When a book is intended for ready reference, the user cannot be expected to look through the whole work to find the meaning of the symbols. The engineer who does technical writing should train himself to state everything that he writes just as clearly, simply and directly as possible. These criticisms, of course, also apply to the writing of articles for mechanical journals and to the presentation of papers before engineering societies, because the same principles apply as in the writing of engineering books.

* * *

NEW DEVELOPMENTS IN MACHINE TOOL DESIGN

During the war period, American machine tool builders were so busy meeting the demand for their product that little time could be given to designing improvements on existing machines, or to experiments with entirely new developments. But since the armistice, the thought and attention of designers and manufacturers have been turned to improvements and developments that will continue the leadership of American machine tools. There are several reasons for a decided advance at this time. The extreme conditions in factories producing war materials have brought out defects in the design and construction of machine tools which were not evident before. Many new ideas, which could not be immediately developed, occurred to those responsible for past advances in machine tool design and construction, and there is now time for working out these. There have already been some radical departures from existing designs, and it is certain that many new developments will be recorded.

Present conditions are favorable for results, as manufacturers now are inclined to experiment thoroughly with new ideas suggested by their experience during the war; and the keener competition which they all anticipate increases the necessity for saving wherever possible. Two tendencies are strongly in evidence in the designs that have already appeared. One is the strengthening of machines to secure greater accuracy, because of freedom from vibration and chatter, and to obtain greater capacity for heavy cuts. The other tendency is toward simplicity of drive and operation, our war experience having shown that machines which are simple to operate can be handled by men and women with little or no training.

There is no doubt that the development of machine tools is proceeding along the best lines to insure greater accuracy, capacity, and simplicity of operation. Present machine tool developments differ in this respect from some of the earlier periods, when the greatest efforts seem to have been concentrated on producing such refinement in design and so many additional features that the idea of simplicity of operation was almost lost sight of.

A Task for the Bureau of Standards

An experienced machine shop foreman once said that a good mechanic knows how to slight work. This was the foreman's way of saying that mechanical work should not be done better than is necessary, nor should time be wasted on that which does not contribute to commercial value. Polishing a metal surface to improve its appearance may make an article more salable and for that reason may be useful work, but when machine parts are made more accurate than they need to be, time and money are wasted—a fact well known to experienced manufacturers of machinery and tools. If an automatic screw machine will turn out a finished piece every thirty seconds that is within 0.003 inch of a given diameter, and if this piece is as satisfactory in a mechanism as one that is hand-lapped but does not vary 0.0005 inch, the uselessness of the lapping operation is apparent.

Relation between Accuracy of a Product and its Cost

Many manufacturers who did war work for the United States and other governments have come to realize, as never before, the vital relation between *accuracy* and *cost*. When work on government contracts first started, the exceedingly small tolerances that were demanded crippled production. On their own work as well, many manufacturers delay production because the degree of accuracy considered necessary is not based upon the actual requirements.

There are several reasons why tolerances or allowable errors are often smaller than they should be. Designers usually err on the side of safety, and unfortunately some government work is under the supervision of men who do not realize that the tolerances given on a drawing may, if too small, increase the production cost from several hundred to several thousand per cent. Frequently, those who set the limits of accuracy know that small tolerances are safe and while the unnecessary accuracy may greatly increase the manufacturing cost, nothing definite is ever determined on this point; but if the tolerances are too large, there will soon be trouble, and, therefore, the safe plan is considered the better one. That this procedure is common is to be expected, because there is little definite information or data on tolerances available at the present time. Another reason why tolerances are often too small is that many manufacturers believe that they are capable of producing work on a manufacturing basis more accurately than is practicable by the use of ordinary tool equipment. One large manufacturing concern believed that a tolerance of 0.0002 inch could be maintained without difficulty on screw threads required in large quantities on a certain war contract. The result was no production and absolute failure to fulfill the contract.

Why Accuracy of Machine Parts should be Based upon their Operating Requirements

In almost every form of mechanism there are certain clearance spaces between different movable parts, and tightly fitting pieces are also assembled in fixed relation to one another. The clearances in the bearings of a crude device like a wheelbarrow can be quite large and not cause trouble, but in the action of a rifle, they must be very much smaller. Reducing the clearances means greater accuracy; it also means greater expense because of the increased accuracy required. Consequently, a competent manufacturer aims to construct a mechanism that is only as accurate as it needs to be to operate satisfactorily. Greater refinement is a drag on production, and the effect is sheer waste whenever the rate of production is reduced on account of the accuracy demanded. Of course in many cases the extreme allowable error is not essential to economical production, as for example, when the most efficient type of machine tool obtainable will maintain in the product greater accuracy than is actually required.

Can tolerance data be placed on record that will be of great value to the machine-building industry? We believe that this can and should be done and that it is a job big enough and important enough to engage the attention of the Bureau of Standards which is now so well organized and equipped for research work. The manufacturers of the country need reliable information which represents first-class practice in various lines. While the clearances and resulting tolerances for any mechanism should be based upon the functioning of that particular mechanism, reliable tolerance data which have proved satisfactory for different classes of mechanisms will be invaluable. The cooperation of manufacturers is necessary in the collection of such data, because it must represent what has been found from experience to be reliable. An essential part of this work is the task of sifting, classifying, and checking such data, and while many difficulties would doubtless be encountered, the direct value of classified tolerances to the machine and tool manufacturers, would greatly overshadow the cost of the work. The meager information on tolerances that now exists is scattered and needs to be collected and verified.

Kind of Tolerance Data that would be of Great Value to Manufacturers

When a company is organized to manufacture some product, such as gasoline motors, for example, if the tolerances are on record which have proved satisfactory for this class of work, they would be extremely valuable as a guide and usually be directly applicable. Such data for various other general types or classes of machinery could be obtained either directly from manufacturers or as the result of experimental and research work when necessary. While it could not be absolutely standardized and classified, modifications to suit special conditions could easily be made. The great need is for tolerance data representing good average practice. In the article on "Principles of Interchangeable Manufacture," by Major Buckingham, which begins on page 1024 of this number, attention is called to the fact that in most cases the tolerances originally adopted are increased during the process of manufacture without detriment to the mechanism. It is also pointed out that tolerances rarely need to be reduced, as the mistake is usually in the other direction.

While tolerances for manufactured products have been emphasized, this is not the only subject which needs attention. Data covering tolerances on gages and allowances for different classes of fits would also have great commercial value, as well as educational work concerning approved methods of expressing tolerances on drawings and the standardization of all practice which tends to promote the manufacturing of machinery on an interchangeable basis.

Various branches of the Department of Commerce, especially the Bureau of Standards, have done remarkable work in assisting the manufacturers of the country who have been requested repeatedly to use more extensively the new and greatly improved facilities which have been provided at Washington. MACHINERY suggests this subject of tolerances and the standardization, wherever possible, of practice affecting interchangeable manufacture. Lack of definite knowledge about *necessary accuracy* greatly delayed our war preparations and illustrated forcibly the truth of the old foreman's remark about knowing how and when to eliminate useless effort.

Disposing of Government Machine Tools

IN order to prevent the flooding of the market with machinery and tools in a manner that would upset the industrial conditions in general, the office of the Director of Sales was created by the Government with authority to make sales for the War Department of machinery, tools, and other products no longer needed by the Government. By a War Department order dated January 17, 1919, C. W. Hare, then assistant director of munitions, was appointed director of sales. The materials to be sold by the War Department are classified under the following sections: Contractors' and railroad equipment and building material section; plant facilities section; machine tool section; motor vehicles, vehicles, and aircraft section; quartermaster stores section; ordnance and ordnance stores section; and war materials and scrap section.

The office of the Director of Sales is not intended to be a selling agency, but merely to exercise general supervision over the disposal of the surplus war material and to formulate sales policies and methods of sale, and to fix the price at which the commodities should be sold. The actual selling is done by the several bureaus of the War Department, in one of four different ways, viz.: (1) For cash at auction; (2) to the highest bidder on sealed proposals; (3) at current market prices (no sale at the current market price shall be made except under continuously maintained competitive conditions and with full publicity); (4) by negotiations under competitive conditions, provided the price obtained is not less than a price fixed by appraisal, or is the highest of not less than three independent competitive bids.

The Machine Tool Section

The machine tool section which is now headed by Charles E. Hildreth (present address: Chief, Machine Tool Section, Office Director of Sales, P. S. & T., General Staff, War Department, Washington, D. C.), was created early in January of this year to gather information relating to the sale of the machine tools in the hands of the War Department. The first work to be done was to take an inventory of the machine tools to be disposed of, and to make an appraisal of the machines to be sold. In order to determine a plan whereby the appraisal could be readily made in a uniform manner, the machine tool section took up the question early in February with the several bureaus of the War Department, and later with the War Industries Readjustment Committee of the American Society of Mechanical Engineers, consisting of G. K. Parsons, of New York, a consulting engineer; Erik Oberg, of New York, editor of MACHINERY; and Frederick A. Scheffler, of New York, a supervising engineer. As a result of these cooperative efforts, a graphical chart for appraisals was adopted late in May at a conference in New York participated in by the members of the War Industries Readjustment Committee and Majors C. E. Fitch and G. B. Dusinberre of the Ordnance Department, and C. E. Hildreth, chief of the machine tool section, and V. C. Kylberg, assistant chief of the machine tool section. Guided by this chart, the person making the inventory also makes an appraisal of the condition of the machine tool inventoried, working in conjunction with three practical machine men at the plant. This appraisal shows the service value of the machinery. With this information the section will have a uniform method of arriving at selling prices from a price chart which has been especially prepared for the purpose.

Chart for Appraisal of Machine Tools

The chart shown in Fig. 1 is used in the appraisal of machine tools. The object of the chart is to determine the service value of a machine tool that has been in use for a certain number of years. The directions outlined in the following are given by the Government for use in connection with this chart:

"In using this chart, ascertain from the best sources as completely as practicable, preferably from shop superintendents, foremen, United States inspectors, or plant records, for each tool or group of tools: Actual time of use in years; average number of hours per day in use; class of usage and upkeep.

"Reduce the actual time of use to the equivalent standard eight-hour-day usage by the reduction factor obtained from the chart Fig. 2.

"Enter main chart with equivalent years of use on base line, read vertically to appropriate curve, then horizontally to left for percentage of condition. This percentage is to be recorded on inventory card unless altered in accordance with the next paragraph.

"Examine the tool for evidences of: (1) Exceptionally good care, maintenance, and operation. If justified, the percentage derived under preceding paragraph may be increased, but not to exceed 5 per cent. (2) Abuse or exceptionally poor care, either in usage, upkeep, handling or storage. If justified, the percentage derived from preceding paragraph may be decreased, but, in general, not more than 10 per cent. The use of the "overworked" curve will cover most cases. (3) Broken or missing standard parts or equipment. This can be taken care of by an appropriate reduction from the percentage previously determined unless cost of replacement can be estimated with reasonable accuracy, which is preferable. (4) The percentage determined by the directions in the preceding paragraph, as altered by the directions (1), (2), and (3), is to be entered on the inventory card, and noted in "Remarks" with brief statement of reasons for the exercise of special action.

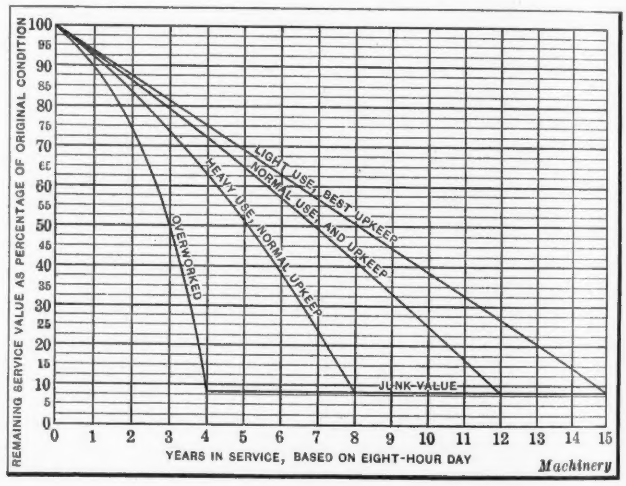


Fig. 1. Chart for determining the Remaining Service Value of Used Machine Tools

"Original cost, market price, obsolescence, amortization and demand are not to be considered in using this chart, but are separate factors in price determination."

Example—Assume that a machine has been used six years, having had normal use and upkeep. By locating six years on the bottom scale in Fig. 1, and following the vertical line from this point to the curve marked "normal use and upkeep," and by following the horizontal line from the point of intersection with this curve until it reaches the scale to the left, it will be found that the service value of this machine is 57.5 per cent.

Reduction Factor Chart

The chart shown in Fig. 2 is used in conjunction with the chart shown in Fig. 1 to obtain uniformity of results in those cases where machines are operated longer than eight hours per day, which is the working time upon which the chart Fig. 1 is based. Having determined the number of hours per day at which the tool has been operated, locate this number on the scale at the bottom of the chart Fig. 2, follow the vertical line to the curve in the chart, and from the point of intersection with the curve follow the horizontal line to the scale on the side, on which the reduction factor is read off. This reduction factor is multiplied by the time in years that the machine has actually been used in order to obtain the number of years of eight hours per day equivalent to the number of actual years at a greater number of hours per day.

Example—A machine tool has been operated for a term of 2 years at 16 hours per day. From the chart in Fig. 2 the reduction factor is found to be 2.25. By multiplying this factor by 2, which is the period of actual use, the result of 4½ is obtained, which is the equivalent number of years on an eight-hour basis, and is the time that should be used in reading off results from the main chart Fig. 1.

How the Inventory and Appraisal Information will be Used

With the information arrived at through its inventory form and appraisals system, the machine tool section will be

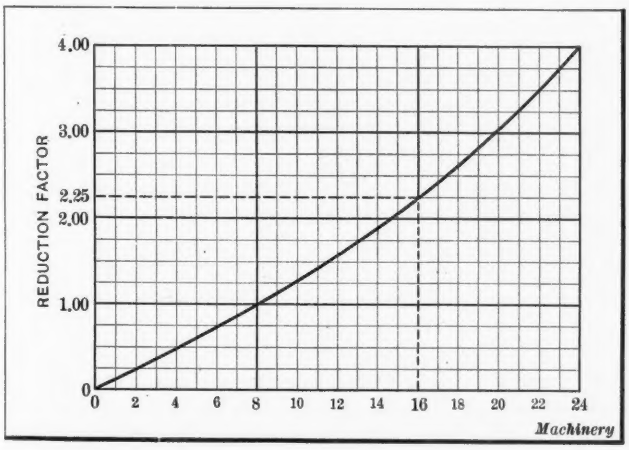


Fig. 2. Chart for obtaining Reduction Factor for converting Actual Time of Use to Equivalent Standard Eight-hour Day

in position to recommend sales policies and methods and proceed to the establishment of prices. Having fixed the price on the machinery, the section will then catalogue it. As each tool is inventoried, appraised, and priced, it will be listed with each of the zone or district offices of the War Department, so that each of the sales offices will be in a position, whether the machinery desired is in its territory or elsewhere, to furnish to prospective purchasers complete information as to the number of each tool on hand at any time, their location, their condition, and prices.

* * *

WILLYS OVERLAND CO.'S TRAINING COURSE

The Willys Overland Co. of Toronto has established a department in its automobile factory for the technical training of its employes. The men enter this course of training only at their own request and old employes while in training are paid within 10 per cent of their former wages. Men may enter or leave the training department at any time. They may return to their old positions or, if successful in their training work, they will be promoted to better jobs at higher wages, receiving at once the standard rate for the new work for which they have qualified. Training is offered in general machine work covering various types of machines that are used in production, toolmaking and diemaking, blueprint reading, applied mathematics, and other technical courses, including a course in foremanship.

WILL THE SMALL TOWN REGAIN ITS INDUSTRIAL IMPORTANCE?

In the early development of the industries in the United States, most of the factories were located where water power could be obtained for the driving of machinery. Hence small towns sprung up along the rivers throughout New England; many of these towns have retained their industrial importance while others have become less important, the industries —no longer depending upon the water power—having moved to larger cities. During recent years, however, there has been a tendency to locate new industries in small towns on account of the many advantages that the small town offers as compared with the large cities, especially in industries requiring skilled labor. The labor supply in the smaller community is generally more stable, and a better class of labor is attracted because the living conditions, at the present time, are generally better in smaller communities. There is a chance for the working man to own his home, which is seldom the case in the larger center. Furthermore, there is less competition for the available labor, so that the labor turnover is less, and the difficulties met with in a large floating labor supply are absent.

These and many other advantages are being recognized by manufacturers in the machine building field, and there is now a tendency for many industries to establish themselves in smaller towns. This tendency is being aided in some instances by a public-spirited movement on the part of the business men already established in these smaller communities. Danbury, Conn., offers an interesting example of this. Here the Danbury Industrial Corporation has been formed by the leading business men of the town with a view to attracting and offering inducements to new industries to establish themselves in the town. The Danbury Industrial Corporation is incorporated and capitalized with a view to aiding new industries in starting business. In some instances land is furnished free and buildings will be erected subject to long-term mortgages. Meanwhile, efforts are made to make the living conditions for the labor of the town as satisfactory as possible and to make the community a desirable location for new industries. The whole movement was brought under way by the efforts of but a few men, although it now embraces practically all the leading business men in the town. It is likely that the example of Danbury will be followed by other small towns.

If in addition to the inducements for the location of the industries in these smaller towns an effort is made to aid the workers to purchase and own their own homes, facilities being provided for making this as easy as possible, the movement is one of the most important in the industrial life of the country; because nothing would promote industrial peace more than the improved living conditions made possible by having large numbers of men own their own homes in small communities where their interests would be closely identified with the common interests of the community.

* * *

HISTORY OF PRICES DURING THE WAR

The War Trade Board is now publishing a history of prices during the war which covers thoroughly the whole field of prices, from the beginning of 1913 to the end of 1918, in fifty-four representative trades. The bulletins are designed to meet the needs of business men in each important trade and industry and will be issued in fifty-four bulletins, the first three of which are general and the remainder covering specific trades. The first bulletin will be a general summary; the second will be entitled "International Price Comparisons"; and the third "Government Control over Prices." Of the other bulletins those of especial interest to the machine-building and allied trades will be No. 33, "Iron, Steel and Their Products"; No. 34, "Ferro-alloys, Non-ferrous and Rare Metals"; and No. 35, "Coal and Coke." These bulletins may be obtained by applying to the War Trade Board, Washington, D. C.

Promoting Cooperation between Employer and Employe

By G. E. RANDLES, Vice-president, Foote-Burt Co., Cleveland, Ohio

IN the effort that has been made to establish friendly relations between employers and employes during recent years, many new ideas have come to the front. Some of these have been good and have produced the desired effect, but many of the new ideas contain dangerous elements and will not accomplish the results that are expected. Too great enthusiasm in accepting new ideas in dealing with labor may be just as objectionable in its effects as too great conservatism. In putting the new ideas of welfare work into force, many managers have approached the man in the shop through channels and in ways that the shop man does not fully appreciate nor understand, and he is likely to misconstrue the motives behind this welfare work.

Difference between Past and Present Relations of Employer and Employes

The employers of the old generation who are gradually disappearing, came up through the ranks and had a thorough understanding of the ideas, thoughts, and conditions of the men working at the bench. If differences arose, they could comprehend the men's point of view and could speak to them in a language which the shop men understood. Differences were, therefore, more easily adjusted and mutual understanding and good will was promoted.

Quite a number of the managers of the new generation are of a different type. The young men now assuming the duties of leadership generally have received a different kind of education and pass into industrial work not by the slow process of working from the bottom up, but by being injected immediately somewhere near the top. These men do not have the shop man's point of view and do not generally understand his thoughts and aspirations. They may mean well, but their ignorance of the actual conditions that surround the man working at the bench make it difficult for them to apply themselves to the problems they have to meet in the most effective manner. They do not speak the language of the shop man and are not able to meet him on common ground. There is always a gulf between them and the shop men that is difficult to cross when differences arise, and the result is often friction and labor unrest.

In order to show their good will toward labor, these men are prone to adopt a great many plans for the benefit of the worker, but these plans are conceived not from the working man's point of view but from the point of view of a man who has been brought up and educated along entirely different lines. Much of the so-called welfare work, therefore, is not appreciated by the men whom it is intended to benefit, and sometimes these efforts do more harm than good.

What the Employe Appreciates is Fair Treatment and an Opportunity to Meet the Employer on Common Ground

There is no way of expressing better what the employe expects, and has a right to expect, than to say that he should be given a "square deal," that is, he should be dealt with in a manner that will help him to retain his self-respect and develop his qualities as a producer by making him feel that he is cooperating and working with his employer toward a common end. Scientific plans of profit-sharing and bonus systems may and do involve a great measure of justice, but they are often too intricate and difficult to understand to appeal to the average workman; and when he does not understand the plan of payment he is likely to believe that the plan is so devised as to deprive him of some of his earnings rather than to add to them. The simpler the plan of wage payment the better, because in every case a man will be better satisfied working under conditions which he fully comprehends.

Furthermore, it is not the money reward alone that is appreciated. The war proved that many firms were able to retain their men in spite of the fact that they were not able to pay the high wages that munition manufacturers were in a position to pay. The reason for this was that the men appreciated the fair treatment that they received at the hands of their employers and valued the assurance of a job when the war was over, as they knew from past experience that they would not be discharged at a moment's notice. The manager or superintendent who takes pains to know his employes by name and who speaks to them as he passes through the shop does more to create good will than the man who sits in his office planning an elaborate system of welfare work. Nothing is appreciated more by the men in the shop than to be recognized as being necessary parts of the whole organization that works toward a common end.

Keynote of Proper Understanding between Employer and Employes

Briefly stated, the essential of a proper understanding between employer and employes is an endeavor to meet on common ground. If a conference is necessary between the men and the firm in order to adjust differences, such a conference should be held right in the shop where the men feel at home. By bringing them up into a handsomely furnished executive office a note of discord is immediately introduced. The men will speak their minds freely and honestly when they feel at home. Unusual surroundings prevent them from expressing the opinions they would otherwise be able to state clearly. The employer must learn to see all questions from the shop men's point of view in addition to his own. If by education and training he has not had the opportunity to learn to do this, he is at a great disadvantage as compared with the man who has risen from the ranks; but even with this handicap it is possible for him, if he really wants to do so, to acquire enough of that point of view so that he can deal with his men in a manner that will appeal to them, and to learn to speak to them in a language that they will understand.

* * *

CAMPAIGN FOR TRAINING INDUSTRIAL WORKERS

The Department of Labor is conducting a campaign to impress upon employers the necessity of properly training men for the work that they are to do. It is pointed out that by proper training, the efficiency of American factories may be greatly increased and the labor turnover materially reduced. Both of these factors would tend to create greater profits, making it possible to maintain present wage scales and at the same time secure greater returns on invested capital. Many of the larger firms have adopted extensive methods for the training of employes with a view to increasing the individual efficiency of each worker, and consequently the total efficiency of the whole establishment. This is a subject that may well be studied by employers in general. Each plant would have to decide upon a course suited to its own needs, and in general it is possible for every plant, even the smallest, to adopt some policy and method whereby better training can be given to the employes for the work for which they are hired.

Conditions in the Machine Tool Trade

THE conditions in the machine tool trade are reported by many manufacturers to be gradually improving. Inquiries are plentiful and more orders have been placed during the past two months than during any of the previous months of the year. Buyers have apparently come to realize that the price reductions made are final and that no further reductions are to be expected. In fact, some manufacturers intimate that the reductions made in some instances were too great, and that an increase in price in certain lines is likely, if the present conditions in the labor and material markets remain unchanged.

Activities in the Automobile Trade

The automobile trade continues to remain the most important buyer of machine tools. Activities in the Detroit district in planning and executing automobile projects are encouraging to the trade. It is estimated that about $50,000,000 will be spent during the year for new plant and equipment in the automobile field alone in this district. The tendency is to employ automatic and semi-automatic machines to an ever-increasing extent, the Ford plant probably leading along these lines. It is more apparent than ever that it is the purpose of the automobile builders to decrease the first cost of automobiles so that in spite of higher costs of labor and material, the cost of cars may be, if possible, brought down to the level of 1916. Whether this can be done or not is problematical, but the increased facilities for manufacturing that are in evidence everywhere in the large automobile plants will necessarily tend to decrease the cost of automobiles.

Disposal of Government Machine Tools Abroad

As mentioned in the June number of MACHINERY in the review of conditions in the machine tool trade, on page 972, American machine tools owned by the United States Government have been sold in Belgium at 10 per cent below the current market price, it also being reported that in some instances payments have been extended over a period of as much as three years. The Cincinnati machine tool builders have protested against this policy of the Government and have sent a telegram signed by twenty machine tool builders to the senators and congressmen from Ohio. This telegram reads as follows: "Please do what you can to prevent dumping of government machine tools on foreign markets, as it will seriously affect every tool plant in Cincinnati and the country at large. Truck manufacturers stopped this, why can't we? If the surplus machines must be disposed of, why not arrange that Germany and Austria absorb them in their initial requisitions?"

Disposal of Government-owned Machine Tools in the United States

The plans for the disposal of the government-owned machine tools in the United States are progressing under the direction of Charles E. Hildreth and V. C. Kylberg, and definite plans have been made for determining the service value of used machine tools, so that the price at which these tools are to be sold can be properly ascertained. The details of this plan are outlined in the article "Disposing of Government Machine Tools," on page 1034 in this number, where charts are also shown that have been prepared for determining the service value remaining in a machine tool that has been used for a certain number of years under various conditions.

The Caldwell Bill, which was introduced in the last session of Congress and which contained provisions for lending the government-owned machine tools to educational institutions, but which failed of passage at that time, has been reintroduced by Congressman Caldwell. The bill is known as H. R. 3143 and is defined as "a bill to provide for further educational facilities by requiring the War Department to lend certain machine tools and scientific instruments not in use for government purposes, to trade and technical schools and universities, and for other purposes." This bill is identical with the bill that was introduced into the last Congress with the exception that it includes scientific instruments. The bill is referred to the Committee of Military Affairs and those wishing to urge the passage of the bill should write to Julius Kahn, Chairman of the House Military Affairs Committee, Washington, D. C., as well as to their senators and congressmen. While there has been some criticism of the provisions of this bill and its practicability, both in military and machine tool circles, it is certain that if the proposition were properly handled, much good could result from the passage of the bill, and there is every reason to urge its passage. While it may not entirely solve the problems of the present machine tool situation, it would tend to aid in establishing proper mechanical educational facilities; and that in itself is an extremely valuable object, particularly at a time when there is so much complaint of the lack of skilled mechanical labor as there is at the present time.

Foreign Trade Aspects

Many machine tool builders find the foreign trade inactive, largely on account of the restrictions upon imports enforced by the French and Italian Governments. The English trade now appears to flow unobstructed, as does also the trade with Belgium. The Scandinavian trade has also revived to some extent. The lack of shipping facilities, of course, has interfered considerably with the foreign trade. The trade with Belgium is improving, because sailings to Antwerp are becoming more frequent and cargo space is less difficult to engage. It is stated that shipments destined to Belgium can now be taken care of with reasonable promptness. Licensed cargoes to Denmark can now move freely, but although a number of extra steamers have been placed on the direct routes to Sweden and Norway, space is difficult to secure owing to the heavy demand. There is no lack of shipping space for commercial cargo to France, but the French Government's embargo obstructs some of the trade.

Scarcity of Skilled Labor

Throughout New England there is a scarcity of skilled labor in the machine industries. Manufacturers state that they are unable to obtain skilled mechanics, and even men trained to operate one type of machine only are scarce. It is true that there are men out of employment in all the industrial centers, but these are men without any trade training and apparently unwilling to learn a trade. They demand journeymen wages for unskilled labor and are not willing to go into the shops with a view to acquiring thorough training in the operation of one line of machines or in all-around machine work.

In several industrial centers in Connecticut manufacturers have been unable to obtain enough men for night gangs in cases where present conditions warrant running the shops at night. Under these conditions, of course, wages remain at their previous high level, and while unemployment is reported in the newspapers and through various other channels, it should be understood that this refers only to labor lacking entirely any training in a specific trade. The problem of unskilled labor is acute, and the reluctance of unskilled men to accept a reduced wage while being taught a trade is one of the most serious industrial problems that confront the manufacturer at the present time.

Semi-annual Meeting of the A. S. M. E.

THE spring meeting of the American Society of Mechanical Engineers, held in Detroit, June 16 to 19, was unusually well attended, and at the professional sessions, papers covering many varied phases of mechanical engineering were presented. One of the important sessions was held on Monday, June 16, when the Committee on Aims and Organization of the society made its report covering many important aspects of the society's activities. A special research session, an industrial relations session, a gas power session, a fuel session, and a general session were held throughout the meeting, and, in addition, arrangements were made for visiting the Burroughs Adding Machine Co.'s plant, the Ford Motor Co., the Morgan & Wright Co., the Ford Eagle plant, and the Connors Creek plant of the Detroit Edison Co.

Of the papers read before the meeting, those of particular interest in the machine-building field were as follows: "The Present Condition of Research in the United States," by Arthur M. Greene, Jr.; "Research Work on Malleable Iron," by Enrique Touceda; "Reports of Sub-committees on Bearing Metals and on Lubrication"; "The Organization and Conduct of an Industrial Laboratory," by A. D. Little and H. E. Howe; "Industrial Personnel Relations," by Arthur H. Young; "The Status of Industrial Relations," by L. P. Alford; "Certain Aspects of the Management Problem," by Magnus W. Alexander; "Production of Liberty Motor Parts at the Ford Plant," by W. F. Berner; "Crude-oil Motors vs. Steam Engines in Marine Practice," by J. W. Morton; "A Suggested Formula for Rating Kerosene Engines," by D. L. Arnold; "Standards of Carburetor Performance," by O. C. Berry; "Mechanical Lifts, Past and Present, and a New Method for their Balancing," by Lieutenant J. F. Robbins; and "General Equations for the Design of Butt-riveted Joints," by A. A. Adler.

Summary of Reports and Papers

The sub-committee on bearing metals presented a report, the substance of which was to indicate that it is impracticable to conduct laboratory service tests which will give general satisfaction, and that much more can be learned from the study of failures and by studying old bearings together with their journals. The report of the sub-committee on lubrication dealt briefly with the effect of pressure upon viscosity, with the effect of temperature on viscosity, and with adhesion and absorption. The report merely points out some of the problems that definitely await solution and does not attempt to present any final statement regarding them.

The Status of Industrial Relations

At the annual meeting of the Society in 1912, a report was presented by the sub-committee on administration, on "The Present State of the Art of Industrial Management." This report was replete with information upon the broad aspect of the management problem as it then existed in the industries of the country. During the seven years that have intervened since the preparation of this report, the question has been studied from many different angles and has come to be viewed in quite a different light from that in which it was regarded when the original report was prepared. In consequence, the committee on meetings and program appointed L. P. Alford a committee of one to prepare a new report upon the subject for presentation at the session on industrial relations at the Detroit meeting.

This report not only comprises a review of the new aspects of the problem which have recently developed, but also a historical summary of the progressive stages in the development of industrial relations since the period immediately following the Civil War. It has proved to be inevitable that after any great economic disturbance like that produced by the Civil War, or the present period of unrest following the world conflict in Europe, there should be unrest and uncertainty in the field of labor and employment; and it thus seems appropriate at this time to outline briefly the most important transitions which have occurred in this field from the time of the Civil War up to the present.

Design of Riveted Butt Joints

In the paper on the design of riveted butt joints, the Schwedler graphical method of designing riveted joints is analyzed and a general equation is derived for determining the pitch of the rivets in any row and for determining the efficiency of the riveted joint. The design of cover plates is also considered. The equations are exemplified by calculations of actual joints, using commercial dimensions.

The Organization and Conduct of an Industrial Laboratory

During the war, industrial research in the United States was naturally stimulated, and as a result there now exists a deeper interest than heretofore in the applications of science to manufacturing processes. New laboratories will undoubtedly be built and many old ones reorganized in order to render more efficient service. It was the purpose of this paper to point out the organization and conduct of such a research laboratory. The authors first outlined the aims of a research organization, following which the divisions of the laboratory were enumerated and discussed, the laboratories of Arthur D. Little, Inc., being taken as a type. The methods of management, writing of reports and the commercial organization of the laboratory were also discussed at some length, and the paper concluded with a description of the building and equipment best suited to carry on this work.

The Present Condition of Research in the United States

This paper, by the chairman of the research committee of the society, dealt with the conditions under which research is now being carried on in the United States. The author first discussed research in its relation to the technical school and gave a list of the universities having mechanical engineering laboratories. Engineering experiment stations were next considered, lists being given of the stations and of those which publish research bulletins. Cooperative research and the research activities of the Government were next presented, and finally the author considered commercial and industrial research work, giving in connection therewith lists of the private research laboratories in the country and of companies having their own research facilities.

The Production of Liberty Motor Parts at the Ford Plant

This paper dealt with the production of Liberty motor cylinders and connecting-rod crankshaft bearings as carried on at the Ford Motor Co.'s plant at Detroit. The contract made with the United States Government called for 5000 motors and these were to be produced at the rate of 50 per day of eight hours. To do this, important developments in the methods of manufacture were brought about by the production department of the Ford Motor Co. One of these was the method of producing cylinders from tubing. Six operations were necessary, which were described in detail. The methods used to produce connecting-rod crankshaft bearings likewise resulted in a great saving of time. Twenty-one operations were found necessary for this work and a complete description of each was given. The paper concluded with an explanation of the method of installing bearings in the upper and lower halves of the Liberty motor crankcase.

Inspection and Adjustment of Lathes

Alignment Tests between Different Parts and Calculations for Determining the Amount of Metal to Remove for a Given Adjustment when Fitting the Carriage or Headstock to the Bed

BY JAMES FORREST

NOW that the war is over, manufacturers are more at liberty to give the long-deferred but desirable attention to machinery which has been called upon to produce for twenty-four hours a day in the past few years. Some of the machines used in producing munitions will be of no further use, but a great number of certain kinds will serve their useful purpose for many years, if given the necessary overhauling. Methods of testing lathes and of correcting errors discovered by the tests will be described in the following, and will serve as an index of procedure for those buying machines which have no guarantee of accuracy, and also for those who have inaccurate ones in their possession. While all machine tools should be kept as accurate as possible, there are some machines, as in the tool-room, the accuracy of which is a vital necessity, it being a well-known fact that the work of a machine will always be slightly less accurate than the machine itself, due to lost motion, deflection, dirt, etc.

There are five principal generating axes or planes on a lathe, each of which must be accurate in relation to all the others, so that the machine may turn out proper work, with surfaces parallel and at right angles to each other. These are in order: The plane of the ways, the plane of the cross-slide, the axis of the headstock spindle, the concentricity of the headstock center with the head spindle bearings, and the axis of the head and tailstock centers.

The Lathe Bed

The bed of the lathe is the base for all the other alignments. Each part will be treated in the proper sequence, and each additional part which is made correct, can then be used as a basis for bringing the remaining parts into alignment. The bed of the lathe is subject to more wear inimical to its function than any other part of the machine, for, by the very nature of the use of the lathe for a standardized output, this wear will be localized at some points and will also be increased by the accumulation of chips and dirt dropping onto its upper surface. The bed ought to be made of close-grained homogeneous iron, with as hard a surface as can be worked, and care should be exercised in the design so that no strains occur as the result of thick and thin metal sections.

When the beds come off the planing machine, they are assembled upon their legs and set up on a perfectly level floor. All handling operations on machine tools should be performed in a careful manner, especially on long members like lathe beds, which are easily sprung. The bed should be scraped to a master straightedge on all surfaces that affect the accuracy of the work produced by the machine, to an alignment in which the spots from the marking lead are from 3/16 to 1/4 inch apart, a thin even coat of the marking material being put on the straightedge. In most scraping operations, the tendency is to use too much "marker," and this should be avoided as it is misleading instead of guiding. After the bed is scraped up straight, it is used as the basis for aligning the other parts, and it must be set up on the erecting floor, absolutely level and true, while the other members are being put into place; otherwise all the close work to follow will go for nothing when the machine is put into operation.

The Compound Rest

The next part to be considered is the carriage and its cross-slide, with the compound rest. The bottom of the compound rest slide may be scraped up to a bearing on a surface plate, and then its V-shaped ways and those of the swivel base scraped together. When the parts have been properly fitted to each other, the compound slide should run with exactly the same grip or tightness, from one end of the swivel base to the other, with absolutely no shake. It is partly upon the excellence of the workmanship on the parts supporting the tool, from the compound rest down to the carriage, that the accuracy of the lathe depends. Even if each individual member has been fitted with the best of care, there will be a certain appreciable, accumulative "give" as the tool takes the pressure of the cut, and this must be reduced to a minimum by excellence of workmanship.

The next point of importance is to see that the swivel base teat fits its socket in the cross-slide. When there is the least shake between these parts, the graduation marks are misleading, because when the bolts are loosened to enable the rest to be rotated, it will rotate about a center *c* (see view *A*, Fig. 1), until the lost motion is taken up. When bringing the surface of the swivel base to a bearing on the cross-slide, care should be taken to have the base bear hardest at the outer circular surface *b*, and the bearing should gradually be made lighter toward the center. This is to make certain of utilizing the full value of the swivel base diameter in giving stability to the toolpost and eliminating deflection and chatter. The final relation of the surfaces is shown exaggerated in the cross-section *B*, the amount of hollow at *K* being 0.0005 inch.

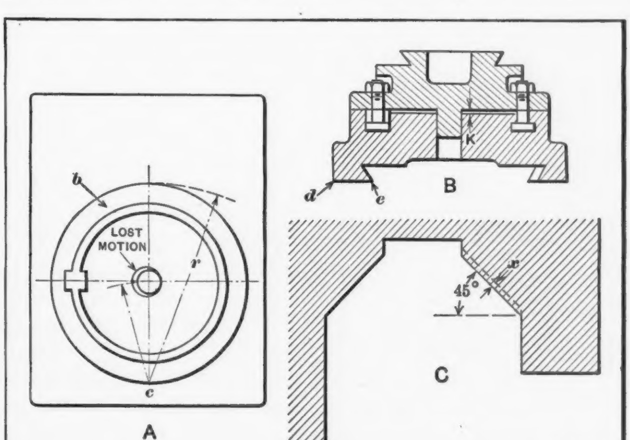


Fig. 1. (A and B) Diagrams illustrating Points on fitting Swivel Base. (C) Section of Carriage Bearing Surface

The bottom surface of the cross-slide can be scraped up to a surface plate in the same manner as the compound

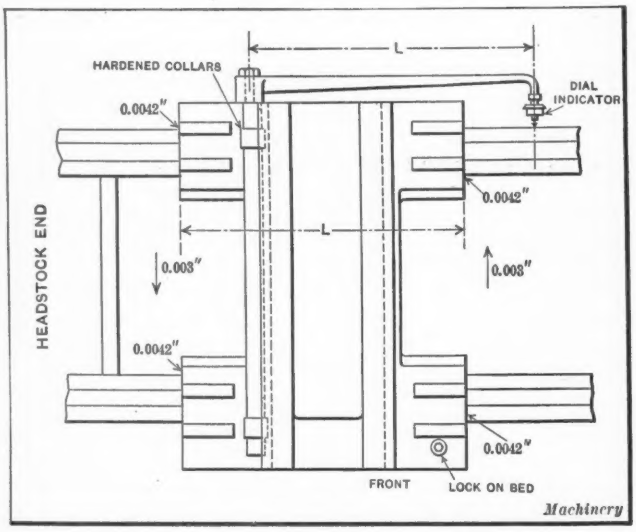


Fig. 2. Method of testing Position of Carriage

rest, and then, in turn, have its V-ways scraped, together with the V-ways on the carriage. When the operation is completed, the pull for moving the slide from one end of the carriage to the other, should be the same throughout. There should also be a good bearing all over the surfaces in contact. When the scraping is finished there should be just the slightest trace of a lighter bearing at *e* than at *d*, (see view *B*), for the same purpose of insuring rigidity as in the case of the swivel base, the principle being that the force required to tip over a column increases as the base is made wider.

Scraping the Carriage to the Bed

The carriage is now ready to be scraped down to the bed, during which process it is set to bring the cross-slide ways exactly at right angles to the bed. The best method of doing this is by the use of a dial indicator fastened to the end of a swinging arm which is attached to a hardened spindle working on one cross-slide V-way on the carriage, as shown in Fig. 2. By making this arm long enough, the error can be multiplied to any amount, but an arm of the dimensions shown can be used to bring the error to within 0.0005 inch in the width of the carriage, and by making it the same length as the carriage, much multiplying and dividing can be saved when calculating the errors.

In order to make sure that faced work will come within the inspection limits, it will be found necessary in practice to give the carriage an initial counter-clockwise position on the bed, of about 0.001 inch or 0.0015 inch in its own length, from the 90-degree position. This allowance is made to offset the tendency to clockwise rotation of the carriage as the tool feeds in when facing, caused by the gradually increasing length of the lever arm between the point of application of the cut and the lock between the carriage and the bed. If the carriage were set exactly at right angles to the axis of the bed, the faceplate would show a tendency to be convex, at the final test, the slightest evidence of which is not allowable.

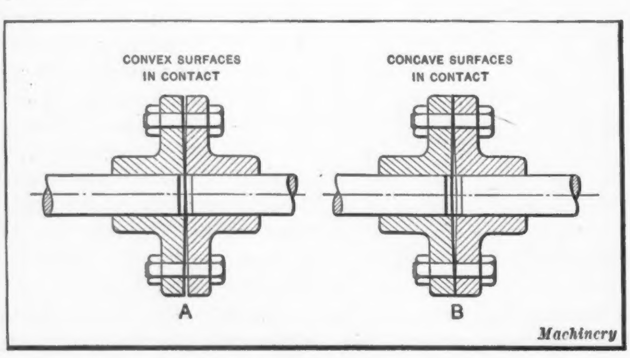


Fig. 3. Examples illustrating why Lathe must face Surfaces either Flat or slightly Concave and not Convex

To test the faceplate, a straightedge is placed across it and the surface must be between the limits of perfect flatness and a concavity of 0.001 inch in 24 inches. This is to insure that any work faced on the lathe will have a tendency to bear around the outer edge, for the previously explained purpose of rigidity and stability. Fig. 3 illustrates the difference between two surfaces machined on lathes with concave and convex errors. When the surfaces of the coupling are convex as at *A*, no amount of tightening of the bolts will make a stable connection, and the axis of one part most likely will be out of line with the other. At *B* the clamping of the bolts causes a pressure between the parts at the outer edges, making a rigid connection, able to resist strain, and the shafts are also held in alignment.

Suppose when the indicator arm is swung over to the side opposite the headstock (as shown in Fig. 2) the dial reading is 0.006 inch positive (a positive reading being one to the right of the zero mark, and a negative reading one to the left), and when the arm is swung over to the side nearest the headstock the reading is 0.004 inch negative. These readings would show that the carriage must be rotated during the scraping process 0.005 inch counter-clockwise in its length L to bring it exactly square, but since the final position should be 0.001 inch counter-clockwise, it must be swung around 0.006 inch, or 0.003 inch at each corner.

In determining the exact amount to be removed by file or scraper, a calculation involving the angle of the ways on the bed is necessary. For example, in the section shown at *C*, Fig. 1, the amount x to be scraped off at one end $= 2\,(0.003 \times \sin 45 \text{ degrees} = 0.0042$ inch, and this will taper off to zero at the opposite end.

When the carriage has been scraped to the correct position and the ways have a bearing all over, so that a 0.0015-inch "feeler" will not enter at any point, the cross-slide, compound rest, and apron can be mounted in place.

Adjustment of the Headstock

The headstock is the next part to be adjusted. When the headstock is in its final position, the axis of the spindle should be from 0.003 to 0.005 inch higher at the faceplate end than at the opposite end, measured at the center lines of the bearings, as the spindle will gradually wear down to a horizontal position due to the weight of the faceplate, chuck, and work, at the large end. Laterally the spindle axis should be theoretically in exact line with the axis of carriage motion on the bed, but it will be necessary in practice to give the headstock an initial rotation clockwise of about 0.001 or 0.0015 inch in its length of bearing on the bed; this allows for yield and spring due to tool pressure, so that faced work will be flat or slightly concave.

A test arbor is made up, as shown in Fig. 5, to fit the spindle nose. It is preferable to have a number of these for the use of the workmen who make the adjustments, and a master for the use of the inspector on the final test. If there is any reason to doubt the accuracy of a test bar, one set of readings may be taken with the lathe spindle and test bar in a certain position, and another set after they have been rotated 180 degrees. When these two sets of readings have been algebraically added and averaged, this average will be a true reading, irrespective of any error in the test bar. It is well to make a point of always testing this way to remove all chance of error. This testing is done with a dial indicator, and if the test rings on the bar are spaced in even feet or inches from the center line of the lathe bearings, much calculation will be eliminated.

Suppose the reading at ring *A* is 11.764 inches and at *B* is 11.763 inches, as measured by a micrometer height gage from the bed to the indicator, after the slide rest has been run back, the height gage being adjusted until the indicator reads the same as it did when on top of the test bar; then the distance from the bed to the center line at $A = 11.764 - 1.750 = 10.014$ inches and at $B = 11.763 - 1.750 = 10.013$ inches, showing a slope down of 0.001 inch in 2 feet, or about 0.0014 inch in 2 feet 9 inches instead of a rise of 0.004 inch,

which is the amount required. Therefore, the end C of the headstock has to be lowered an amount equal to

$$\frac{39\ (0.004 + 0.0014)}{33}$$

= 0.006 inch, to bring it within the limit of alignment with respect to the horizontal plane of the bed.

A reading is now taken with the indicator in contact with the side of the arbor in a horizontal plane, and if, for example, the reading at ring B is 0.0015 inch negative, and at ring A 0.001 inch positive, showing a counter-clockwise rotation of the headstock of 0.0025 inch in 2 feet or nearly 0.004 inch in 3 feet 3 inches, then altogether the headstock must be swung clockwise $0.004 + 0.001 = 0.005$ inch and the ends C and D must be moved 0.0025 inch toward back and front, respectively. If the headstock bearing on the bed is flat, as shown in Fig. 4, there will be no difficulty, as the amount to be removed is the actual quantity calculated; but if the headstock rests upon V-ways, some further calculation is necessary to know how much metal to remove from each surface, in order that the least total amount will be removed to attain the desired alignment in both directions. In this case, the rise and fall of the axis vertically and its rotation horizontally are not independent, and an error in one direction cannot be corrected without causing a movement in the other.

If the previous dimensions are applied to the headstock shown in Fig. 6, the end FH must be lowered 0.006 inch, and moved toward the back 0.0025 inch. The end KG must be kept the same height and moved toward the front 0.0025 inch. Since the headstock cannot be rotated without changing its vertical height, the metal must be removed from the proper surfaces to help attain the desired change in both vertical and horizontal directions. The end FH has to be lowered 0.006 inch below GK, so that for each 0.001 inch that GK comes down, the end FH has to come down 0.007 inch. The total rotation horizontally is 0.005 inch so that the amount to be removed from surfaces $K1$, $G1$, $F2$, and $H2$, must give this rotation and at the same time be proportioned so as to cause the end FH to drop 0.006 inch more than end KG.

Let X = the amount which end GK has to drop; then $X + 0.006$ = the amount which the end FH has to drop, and the

$$\text{total drop} = \frac{\text{total rotation}}{\tan 30\ \text{deg.}} \text{ or } 2X + 0.006 = \frac{0.005}{0.577}$$

$$\text{and } X \frac{0.005}{2 \times 0.577} - 0.003 \text{ inch} = 0.0013 \text{ inch, which will}$$

$$\text{move the end } GK \text{ to the front an amount} = \frac{0.0013}{\tan 60\ \text{deg.}}$$

= 0.0008 inch. The end FH drops 0.0073 inch, at the same

$$\text{time moving back } \frac{0.0073}{\tan 60\ \text{deg.}} = 0.0042 \text{ inch.}$$

The actual thickness of metal to be removed from surfaces $K1$ and $G1$, to move the end GK to the front 0.0008 inch, is $0.0008 \times 2 \cos 30$ deg. = 0.0014 inch. Similarly, the actual thickness of metal to be removed from surfaces $F2$ and $H2 = 0.0042 \times 2 \cos 30$ deg. = 0.0072 inch. The reason for using the multiplier 2 is that in removing a certain amount of metal from the sloping surfaces, the amount must be doubled to get the required rotation. If the amount only equaled the required rotation multiplied by the cosine of the angle of the ways, the headstock would move over the proper amount provided it were kept the same vertical height, as shown in dotted lines in Fig. 7; but in dropping down on the ways, it slides back half way again, and so for every 0.001 inch that it must be moved over, an amount of the metal equal to $0.001 \times 2 \times \cos 30$ degrees must be removed. The dimensions marked at F, H, G, and K, respectively, in Fig. 6 are those which would be marked on the headstock for the guidance of the man making the adjustments.

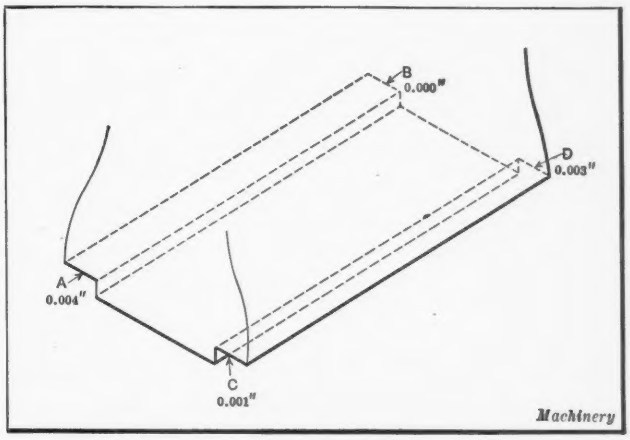


Fig. 4. Headstock with Flat Bearing on Bed

It will happen sometimes that the required vertical adjustment is so great that it is not possible to make it at the same time as when swinging around. As an instance, suppose GK has to be lowered 0.007 inch and the headstock has to be rotated 0.002 inch counter-clockwise. In this case the entire 0.002 inch should be removed from surfaces $G2$ and $K2$, to throw all of its effect into lowering the end GK. The amount to remove from $G2$ and $K2 = 0.004 \times \cos 30$ deg. = 0.0034 inch, and this allows the headstock end to drop $0.002 \times \cot 30$ deg. = 0.0034 inch. The headstock is now square, but there is a further drop required of $0.007 - 0.0034 = 0.0036$ inch, and the equivalent to be removed from surfaces $G1$, $G2$, $K1$, $K2 = 0.0036$ inch $\times \sin 30$ deg. = 0.0018 inch. The marking on the various surfaces for the removal of metal is in this case, $F1 = 0.000$ inch, $F2 = 0.000$ inch, $H1 = 0.000$ inch, $H2 = 0.000$ inch, $G1 = 0.0018$ inch, $G2 = 0.0052$ inch, $K1 = 0.0018$ inch, $K2 = 0.0052$ inch.

Use of One Surface as Basis for Establishing Another Surface

In most cases of final adjustment of the headstock and tailstock, there will be such a small amount of metal to remove that it would not be advisable to set the part up on the machine to remove it, for, in all likelihood, there would be the same correction to make again. The best way to remove these small amounts is to do it by hand, by means of file and scraper. This is generally accomplished by removing what the mechanic thinks is the proper amount, trying the piece in the machine again, then taking off a little more, and so on until the proper fit and alignment are attained, but this is at best a slow and uncertain way of performing a job of this kind. It is astonishing how many men who are otherwise good mechanics, do not understand the proper way to do work of this kind. The important point is not to destroy any plane surface which has been generated by a machine until it has been used as a basis to establish an-

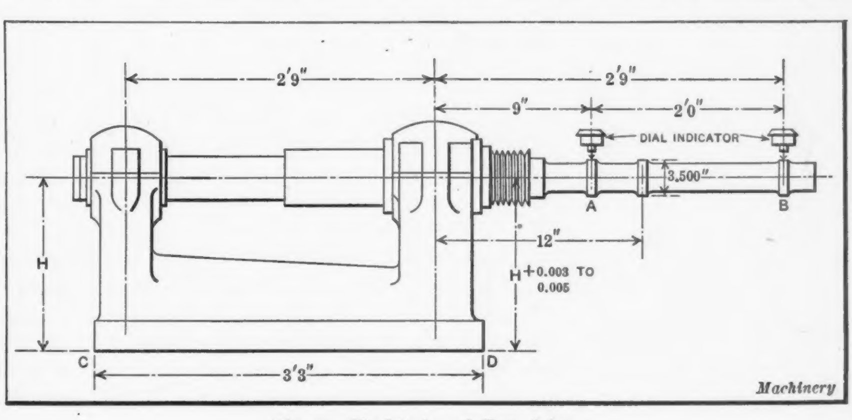


Fig. 5. Headstock and Test Arbor

other surface. If we have a surface *ab*, Fig. 7, and wish to lower *a* to *c* an amount equal to 0.008 inch, and *b* to *d*, an amount equal to 0.002 inch, by starting a file along the top surface from one end to the other we destroy our base, and can only guess at what we have removed, and will have to keep on trying the piece in place often enough to insure that we do not remove too much. The proper method is to remove a section at *a* about 3/4 inch wide and 0.008 inch deep, a section at end *b* 0.002 inch deep, and at the center,—if it is a long piece of work—a notch should be cut wide enough to get a file in and of a depth $= \dfrac{0.008 + 0.002}{2} =$ 0.005 inch. These three new bases, by means of a straightedge and feeler gage, or a micrometer depth gage, are scraped until they are the proper distances from the surface *ab;* then *ab* can be destroyed, as there is now a means of establishing the new plane *cd*. By this means angles can be changed too, and even if the base surface is not correct, just as satisfactory results can be accomplished as if it were, so long as the amount of error is known.

Here is a story which shows an application of the same principle in another trade: Hugh Miller, in "My Schools and Schoolmasters," tells about his uncle, who had the reputation of being the best stonemason in the British Isles. He happened along one day, after tramping from Aberdeen, in front of one of the fine buildings under construction at the time in Edinburgh, and on which there were about eight or ten masons engaged in hewing large stone pillars. Each mason had a pillar to himself on which he had already worked for several days. The foreman was not inclined to hire such a seedy looking tramp as the uncle seemed to be, but was finally persuaded to let him try his hand on a pillar. The first day he did not remove his long overcoat but spent the time viewing and examining the stone from all angles, to the great amusement of all the other masons. The second day he took off his overcoat and chalked and marked the stone from end to end, and on the third day he started in at his stonecutting and finally beat all the other masons by a week's time, much to the delight of the foreman who had been observing the careful preparation made by the stranger, and by this time had guessed that his workman could be no other than the famous stonemason.

Suppose a headstock is marked as shown in Fig. 4 with 0.004 inch, 0.000 inch, 0.001 inch, and 0.003 inch, to come off corners *A*, *B*, *C*, and *D*, respectively; then the procedure would be as follows: As the sum of *A* and *C*, and of *B* and *D*, are not equal, it is apparent that either the headstock or the bed itself is warped, and a corresponding allowance must be made to eliminate rocking. A straightedge must be placed

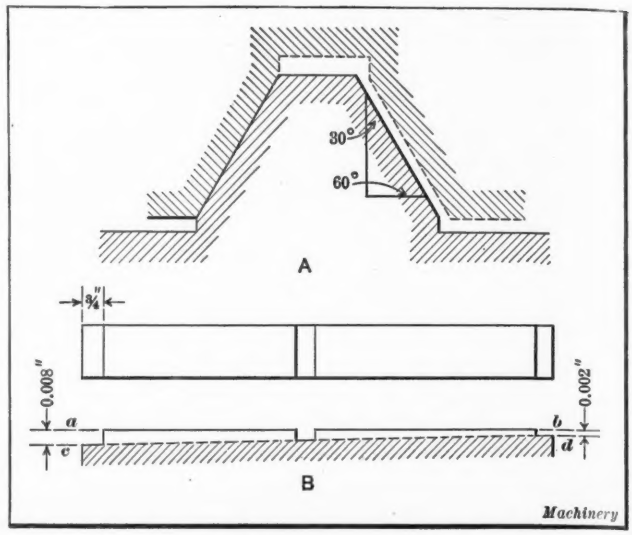


Fig. 7. (A) Section of V-shaped Way. (B) Method of establishing a Surface from a Base Surface

across the bed where *AC* fits and where *BD* fits, to determine what relations exist between one side and the other. It may be that *A* has to be 0.003 inch lower than *C* and parallel to it, or perhaps it has to be tapered off to meet *C*. The straightedge is also put across from *B* to *D* on the headstock on two test pieces, to determine the relation between the opposite sides on the pieces to be fitted, and by means of measurements with an inside micrometer, any combination of relations can be measured for determining the exact amount of metal that it is necessary to remove at any particular point to correct the error.

Tests for the Headstock[Spindle

After the headstock has been brought into proper alignment laterally and vertically, a test for accuracy is made by means of a revolving test bar in the headstock spindle. A collar is turned up on the test bar at a distance of 12 inches from the spindle nose, at which point the inspection card calls for an error of not more than 0.0005 inch. The latter is wholly a matter of spindle accuracy and these limits must be adhered to when grinding it.

The lathe center is then put in place and tested also while rotating. It may happen in the case of a new spindle, that while being rotated in its bearings, the test bar and the lathe center will both show a variation. This may result from improper setting of the center which was used when grinding the spindle, caused by carelessness in removing dirt or burrs. In this case all that can be done to save the spindle from rejection, will be to make the center taper hole true with the outside, if the latter is all right. This can be done by putting a taper reamer in the center hole and rotating it while pressure is applied to make it cut from the side of the hole, which will remedy the error.

At this point the lathe should be put under power and run for three or four hours, the bearings being watched at the same time. Then as a final test of the accuracy of the headstock and cross-slide the faceplate is put on and the finish cut taken across it; the faceplate when finished should lie between the limits of perfect flatness and 0.001 inch concavity in 24 inches, no convexity being allowed.

Alignment of Tailstock

The tailstock is brought into alignment in the same manner as the headstock. The indicator readings in this case are taken from the tailspindle itself, which is extended for this purpose. The limits of error are the same as for the headspindle, namely 0.001 inch in 12 inches vertically and laterally. In fitting the tailstock, there not

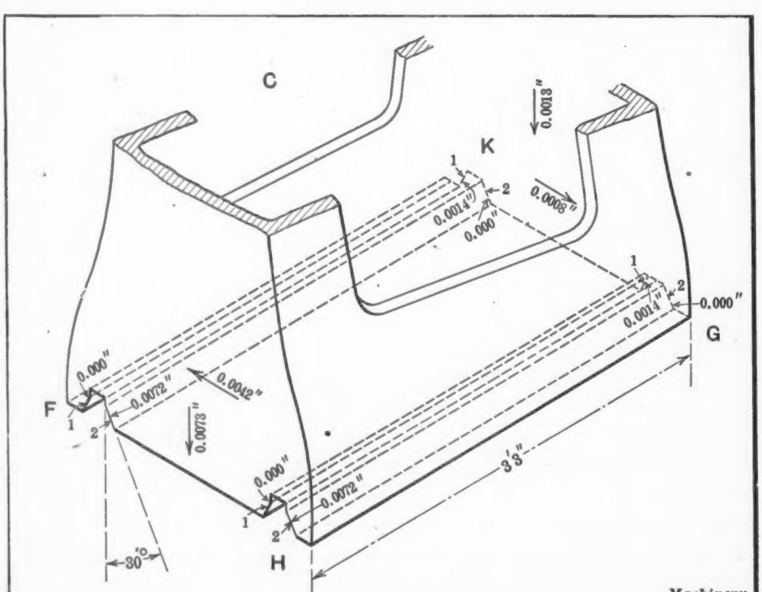


Fig. 6. Headstock having V-shaped Bearing Surfaces

only must be enough metal removed from its sliding surfaces on the bed to align the axis in both directions, but the axis must also measure the same height from the bed as the center line of the rear headstock spindle bearing. This can be tested conveniently by setting the indicator on the head-spindle nose and then running the carriage along to bring the indicator on top of the tail-spindle, making allowance for difference in diameter by means of a gage.

Locating the Zero Marks

The compound rest swivel base will have been graduated in degrees before being put on the carriage, and a simple method of marking the zero is as follows: Place the dial indicator, which is held in the toolpost, in contact with the faceplate which has been faced off, and put the compound rest exactly at the middle of its total travel in either direction. It is assumed that the compound rest slide has been set by the eye, or by measurement with a scale, as nearly parallel with the faceplate as possible. Next move the carriage cross-slide until the indicator is at the center of the headstock spindle. If the compound rest alone is now moved back and forth between its extremes of travel, with the indicator touching the faceplate, and adjustment made by shifting the swivel base until the indicator reading is the same at both extremes, the zero mark on the swivel base will be in the proper place for putting the index mark on the carriage cross-slide. If desired, a mark can be put on all four quarters at the same time.

To locate the zero mark on the tailstock, set the indicator, which is held in the toolpost, against the nose of the headstock spindle and then run the carriage along the bed until the indicator touches the tailstock spindle. The tailstock body can be moved backward and forward on its support, until the difference between the second reading and the first is the same as the difference between half the headstock spindle diameter and half the tailstock spindle diameter. Where there are a large number of lathes to test, it is better to have a gage made equal to this dimension and to indicate to zero in both cases. When the tailstock is set in the proper place on its support, the zero mark can be struck at each end.

The zero mark on the taper attachment is located as follows: After tightening the taper attachment anchor on the lathe bed, slack off the locking nut on the cross-slide, and run the carriage until the center line of the cross-slide ways is at the center of the taper attachment swivel. When this position has been located approximately by the eye, the center may be determined accurately by finding the exact position at which the cross-slide remains stationary, when the taper attachment swivel is swung back and forth by hand between its maximum angles. When the central position of the carriage is found, clamp the locking nut, and while leaving the taper attachment loose, run the carriage to the extreme end of the attachment. The swivel will thus be pulled into the correct position for marking the zero line at both its ends in the center of the graduated arcs. As a final test, after the marks have been scribed, run the carriage to the opposite end of the taper attachment without loosening the clamping nuts, and, if everything has been set properly, the zero marks will not move from their position.

* * *

BRITISH GOVERNMENT REPORT ON MACHINE TOOLS

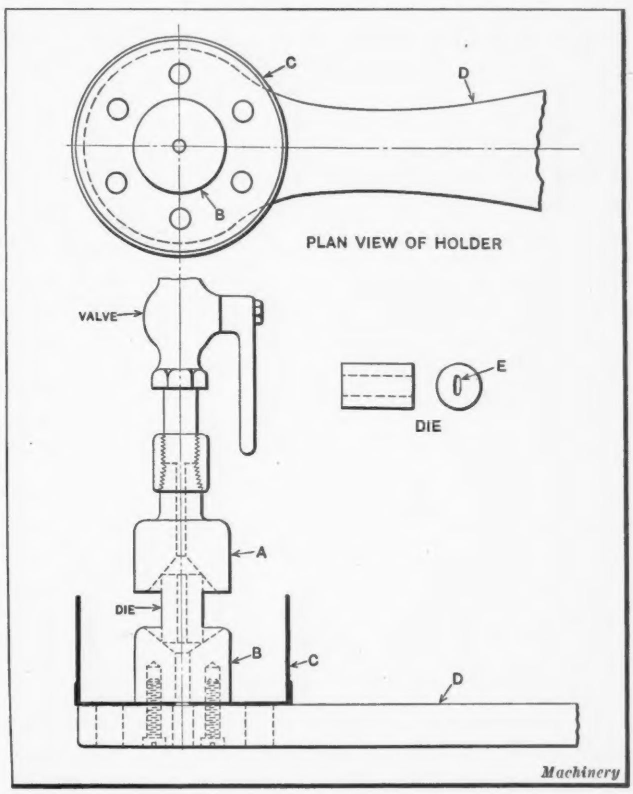
The British Ministry of Reconstruction has issued a report which enumerates the manufactured products previously imported that British manufacturers are now in a position to make. The report on machine tools and small tools presents a list of machines and tools not made in sufficient numbers in England and suggests that British manufacturers make precision grinding machines, and drilling and boring machines. It is also suggested that the Government prevent foreign competition from hampering the production of the new machine tools.

HARDENING THE INTERIOR SURFACE OF SMALL HOLES

BY S. B. ROYAL

Difficulty is often experienced in hardening the interior surface of small holes, such as shown at *E* in the small piercing die in the accompanying illustration. When such work is hardened in the usual manner, the outside of the die may become glass hard while the interior surface of the holes will harden only at the ends of the die, the water that is used in quenching not passing through the hole in sufficient volume to harden it throughout its entire length. Hence the die will need to be rehardened almost every time it is reground in order to keep the cutting edge hard enough to last a reasonable length of time.

The use of the device shown in the illustration should be readily understood. The part *A* has a hole in it through which the water may pass, and is screwed to a pipe or otherwise conveniently fastened directly over the hardening

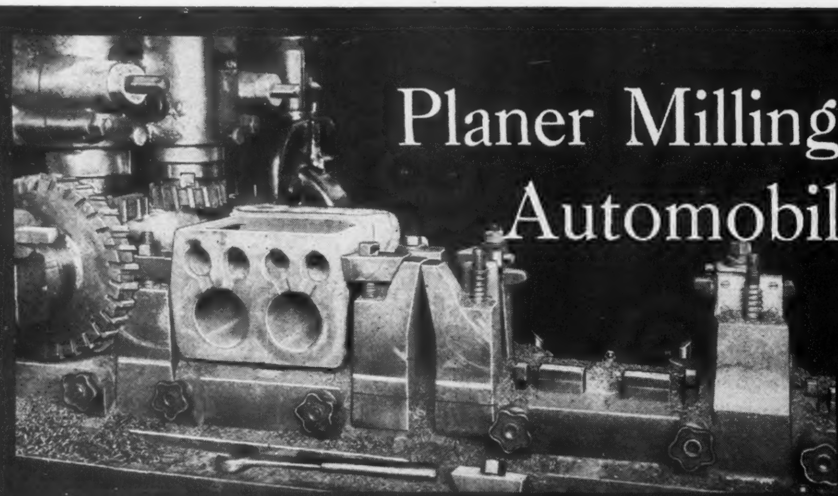


Device for holding and quenching Parts for hardening the Interior of Holes

barrel. The lower part or holder *B* is fastened inside the tin cup *C* which, in turn, is attached to the wooden handle *D*. When the work is placed in the cupped part of holder *B*, as shown, the water will force its way through the hole in *A* and into the hole in the die. The red-hot piece should be held securely in position in the cup of the holder by means of part *A*. By employing this device, no trouble will be experienced in hardening the interior surfaces of holes throughout their entire length, because the water does not touch the outside of the die and cannot, therefore, dissipate any of the heat before passing through the hole. Parts *A* and *B* should be made of brass, and it is preferable to use a brass cup *C*, although a tin can cut in halves may answer equally well. A drainage hole must be provided, of course, in the bottom of the cup to permit the water to run off.

* * *

In the research work on magnetic steel conducted in Germany during the war, one of the points investigated was the substitution of chromium steel for tungsten steel. Bar magnets of chromium steel, stored for a year without being exposed to any disturbance, kept their magnetic moment constant within 0.3 per cent.



Planer Milling Practice in Automobile Plants

By
Edward K. Hammond

Second of Two Articles Describing Methods of Milling Motor Car Engine Parts—This Installment Deals with Milling Operations on Cylinder Blocks and Cylinder Heads

THE milling operations which must be performed on cylinder blocks of the "Super-Six" and "Essex" motors built by the Hudson Motor Car Co., of Detroit, Mich., are performed on multiple-spindle milling machines built by the Beaman & Smith Co., of Providence, R. I. Two machines are used for this work. The first step is to set up three pairs of cylinder block castings on a machine equipped with a single table and a string of fixtures. This machine has two side-heads mounted on the housings, each of which carries an inserted-tooth milling cutter of sufficient size to face off the exhaust manifold seats and the valve chamber cover. It will be apparent from Fig. 9 that each of the three fixtures provides means of holding two cylinder blocks, so that this operation may be performed simultaneously on six castings by cutters carried on the opposed spindles of the side-heads. For the performance of this milling operation, each cylinder block casting is located against three fixed points *A*, *B*, and *C*, on the vertical face of the fixture. Then to assist in supporting the work, there are eight spring plungers *D* equipped with locking screws which hold them rigidly in place after engaging the casting; and the final clamping is accomplished by means of two straps *E* which are provided with handwheels as illustrated. These straps have compression springs beneath them, so that they are raised out of contact with the work when the handwheels are unscrewed.

Before straps *E* are tightened, a yoke *F* is placed over the two castings at opposite sides of the vertical plate of the fixture, and the screw of this yoke is tightened to draw both castings firmly back against their fixed locating points, *A*, *B*, and *C*. While the yoke is still over the castings, the screws which clamp spring plungers *D* are tightened and the handwheels that clamp straps *E* are also turned down. In this way, assurance is obtained that the two castings are accurately located at opposite sides of the fixture; and after they have been tightened up, the yoke *F* may be removed without any danger of the work springing out of place. When performing this milling operation on cylinder blocks for the "Essex" motor, the surface to be milled is approximately 19 inches long by 9¼ inches wide. Owing to the hardness of the metal, the rate of feed employed is rather lower than that called for by average practice, namely, 6 inches per minute; and the cutting speed employed is 63 feet per minute. Operating under these conditions, the production attained for an eight-hour working day is 130 cylinder blocks. On the "Super-Six" blocks, the surface to be milled is 29¾ inches long by 9 inches wide, and on this job, 70 cylinder blocks are milled in an eight-hour working day.

Following the usual practice in milling large sized pieces of work, the surface machined during the first operation on the Hudson cylinder blocks is made the locating point for the second operation. A close view of one work-holding fixture and of the roughing cutters on the machine used for performing this second operation is shown in Fig. 10; and Fig. 12 illustrates a view of the complete machine in order to show the manner in which each section of the divided table is brought back to the starting end of the machine ready to be loaded for the next operation. On this machine, rough- and finish-milling operations are performed on the three faces of the cylinder block, to which the crankcase, intake manifold, and cylinder head will be bolted. The machine is provided with two sets of three cutters. One set of cutters performs the rough-milling operation on three faces of the work, and then the table and work-holding fixture mounted upon it carry the cylinder block between the second set of cutters that performs the finish-milling operation on the same faces.

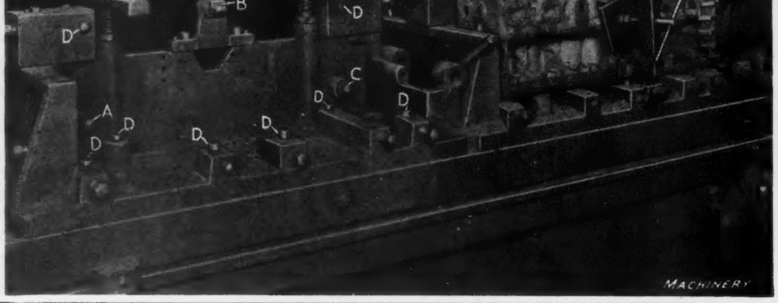


Fig. 9. Work-holding Fixture and Method of setting up Work on Beaman & Smith Multiple-spindle Milling Machine for First Operation on Hudson Cylinder Blocks

In speaking of the design of multiple-spindle or so-called "planer type" milling machines, mention

was made of the fact that the number of parts which must be milled per day is an important factor in assisting the designer to reach a conclusion in regard to the most desirable type of machine to construct for handling a specified class of work. It will be recalled that mention was made of the desirability of using less complicated and therefore less expensive machines for handling the work where a high rate of production is not an important consideration. This was the reason why the designer decided to build a relatively simple machine for performing the first operation on Hudson cylinder blocks, which is equipped with a single set of roughing cutters and a plain table upon which a string of work-holding fixtures is mounted. The reason for deciding upon the use of a machine of this type was primarily that the first operation of milling the seats for the exhaust manifold and for the valve chamber cover plate is shorter than that performed on the second machine, and owing to the higher rate of production, it is needless to take advantage of the continuous operation feature of the divided-table machine in order to increase production. As a matter of fact, the machine used for the first operation is able to accumulate work more rapidly than it can be taken care of by the second machine.

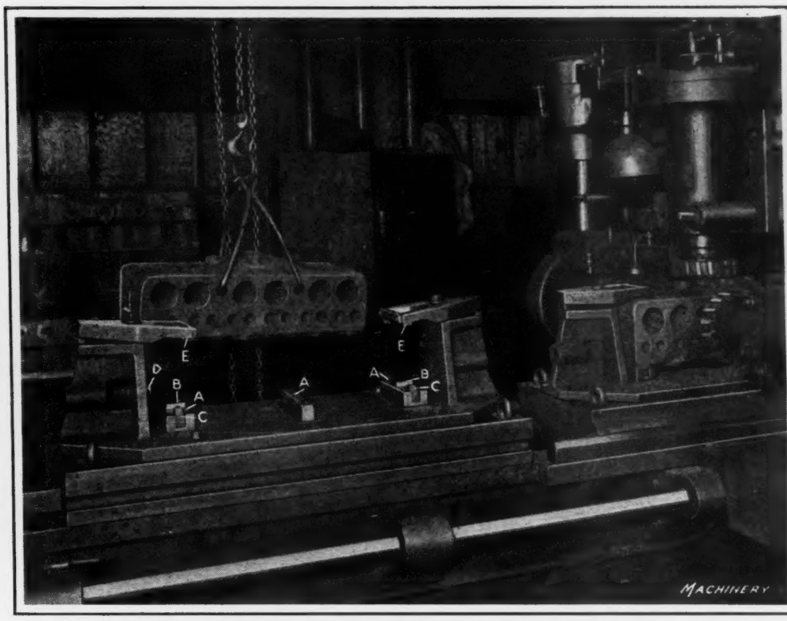


Fig. 10. Work-holding Fixture and Method of setting up Work for Second Operation on Hudson Cylinder Blocks

With this preliminary explanation of the reasons governing the selection of two different types of machines for performing the first and second operations on Hudson cylinder blocks, a description can be given of the routine which is followed in setting up and removing work from the divided-table machine on which the second operation is performed. As each section of the table carries its work between the second set of milling cutters, which performs the finishing operation, the fixture is unloaded and picked up by a trolley hoist that carries it around to the starting point on the milling machine bed. The two machines on which the first and second operations are performed, are set up with the beds end to end and with the tables running in the same direction. As the fixtures on the first machine are unloaded, the milled castings are picked up with a trolley hoist and carried off to a pile which is built up near the starting end of the machine on which the second operation is performed. Then as each table is brought back to the starting point and lowered onto the bed, a cylinder block casting is taken from the pile and lowered into the fixture. The ideal procedure would, of course, be to have the castings taken directly off the first-operation machine and carried over to the second machine, synchronizing the speed of the two machines so that their production would be equal. This procedure has been found impracticable in the present case, however, because the first machine produces much more rapidly than the second one, and hence the necessity of accumulating a reserve of castings around the machine on which the second operation is performed.

The machine on which the second operation is performed is equipped with four work-holding fixtures and two sets of three milling heads, one head of each set being mounted on the cross-rail and one on each of the housings. Cutters carried by these heads provide for rough-milling the faces to which the cylinder head, the crankcase, and the intake manifold are bolted. There is a similar set of cutters mounted on a second housing to provide for the performance of finish-milling operations on the same faces of the work. In order to explain the design of the work-holding fixtures on this machine, attention is directed to Fig. 10, where it will be seen that there are three finished faces *A* which support the work from the surface of the exhaust manifold seat and valve chamber seat, which were milled during the first operation. This provides for holding the cylinder block in a horizontal position; but as the top and bottom surfaces of the block are to be milled, it is important to have the casting located in such a way that these surfaces will be accurately aligned with other faces of the work. This location is accomplished by means of two blocks *B* which engage fixed points cast in the valve chamber of each cylinder block for that purpose. The casting is held back against these blocks *B* by means of hooks *C* which engage the casting, and it is drawn to the desired location by screws that are manipulated from the opposite side of the fixture. The casting also rests against the head of screw *D* which provides for supporting the end thrust. After being located in this way, the casting is clamped down in the fixture by means of two straps *E*. This operation is accomplished at a speed of 65 feet per minute with a feed of 11 inches per minute, and the rate of production obtained is 150 cylinder blocks in an eight-hour working day.

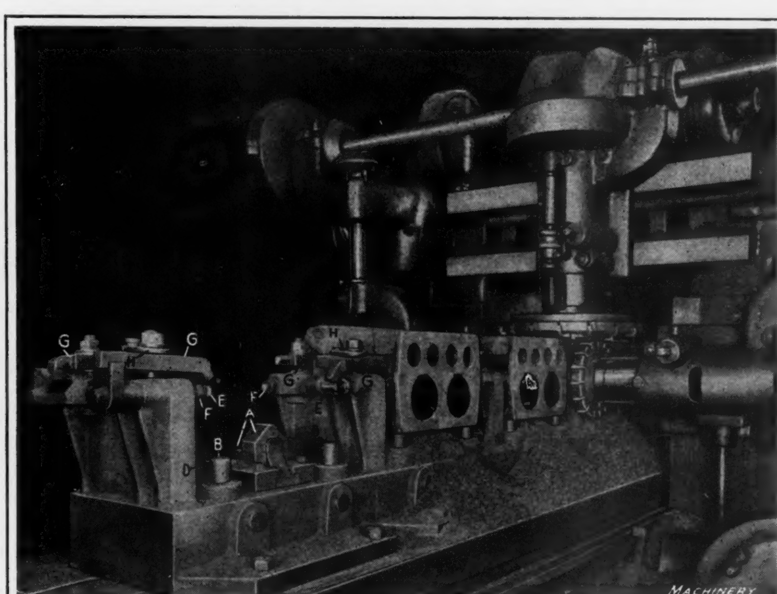


Fig. 11. Ingersoll Multiple-spindle Milling Machine with Interlocking Cutters which produce Sharp Edges required on Hinkley Cylinder Blocks

Practice of Hinkley Motors Corporation in Milling Cylinder Blocks

The Hinkley Motors Corporation, of Detroit, Mich., is engaged in the manufacture of motor truck engines which are furnished with a cylinder block that requires the faces on which the cylinder head, crankcase, and the manifold and valve chamber cover are mounted to be machined in such a way that the edges of the block are sharp. This feature of the work would not present an unusual condition in machining were it not for the desirability of finishing all of these three faces at a single operation. The obvious method of procedure in handling this job was to decide upon the use of a multiple-spindle type of milling machine, but to provide for employing such an equipment special means had to be provided to produce sharp edges at the intersection of the finished faces of the work and still avoid interference of the milling cutters. A multiple-spindle milling machine built by the Ingersoll Milling Machine Co., of Rockford, Ill., was selected for performing this operation and the sharp edges required on the work were obtained by the use of interlocking milling cutters which are arranged as shown in Figs. 11 and 13. Such a method of tooling up the machine provided for finishing the work to the desired form; but care had to be taken to design the milling cutters with their teeth so spaced in relation to the speed of each cutter that there would be freedom from interference of the teeth.

In order to understand the method of setting up cylinder block castings in the work-holding fixtures that are used on this machine, attention must be given to both of the illustrations in order to see the way in which the operating members of these fixtures are arranged at both sides of the milling machine table. The rough castings are dropped into place in the fixture and held on three suspension points *A*, two of which are fixed plugs, while the third is a wedge-shaped block that enters the space between the outer walls of adjacent cylinders. In addition, four spring plungers *B* engage the work, and these are locked by screws *C*. It will be seen that the wedge-shaped block *A* is carried on a cross-slide so that it may be drawn back by screw *D* to provide for pulling the entire cylinder block backward to bring the bosses cast under the flange into contact with two fixed stops which are best shown at *E* in Fig. 11. Jacks *F*, located in the side walls of the fixture, come into engagement with the ends of the casting to provide for supporting the thrust of the milling cutters and also to locate the work in the required endwise position.

To provide for holding the work down in the fixture, there are four straps *G* which engage each corner of the work. It will be seen that two of these straps have cylindrical shaped ends which enter holes in the casting, while the straps at the opposite side are tightened down onto the top of the same bosses which are engaged on their inner sides by pins *E*. It will be apparent that the two straps which engage bosses under the flange of the cylinder block are fastened with a C-latch *H* which goes under the clamping nut. The hole in the strap is of sufficient size to pass the nut, so that it is merely necessary to slightly loosen the nut, after which the latch may be swung back and the strap lifted over the nut. The other two straps have compression springs beneath them, and the work can be disengaged after these straps have been slightly loosened without requiring them to be removed from the fixture. These provisions are the means of saving considerable time in loading and unloading the fixture. In performing milling operations on these cylinder blocks, five castings are set up on the machine table, following the usual routine employed in operating such machines. It requires thirty minutes to feed five castings between the cutters which run at a speed of 75 feet per minute. The rate of feed employed is about 5 inches per minute, and 75 cylinder blocks are produced in a nine-hour working day.

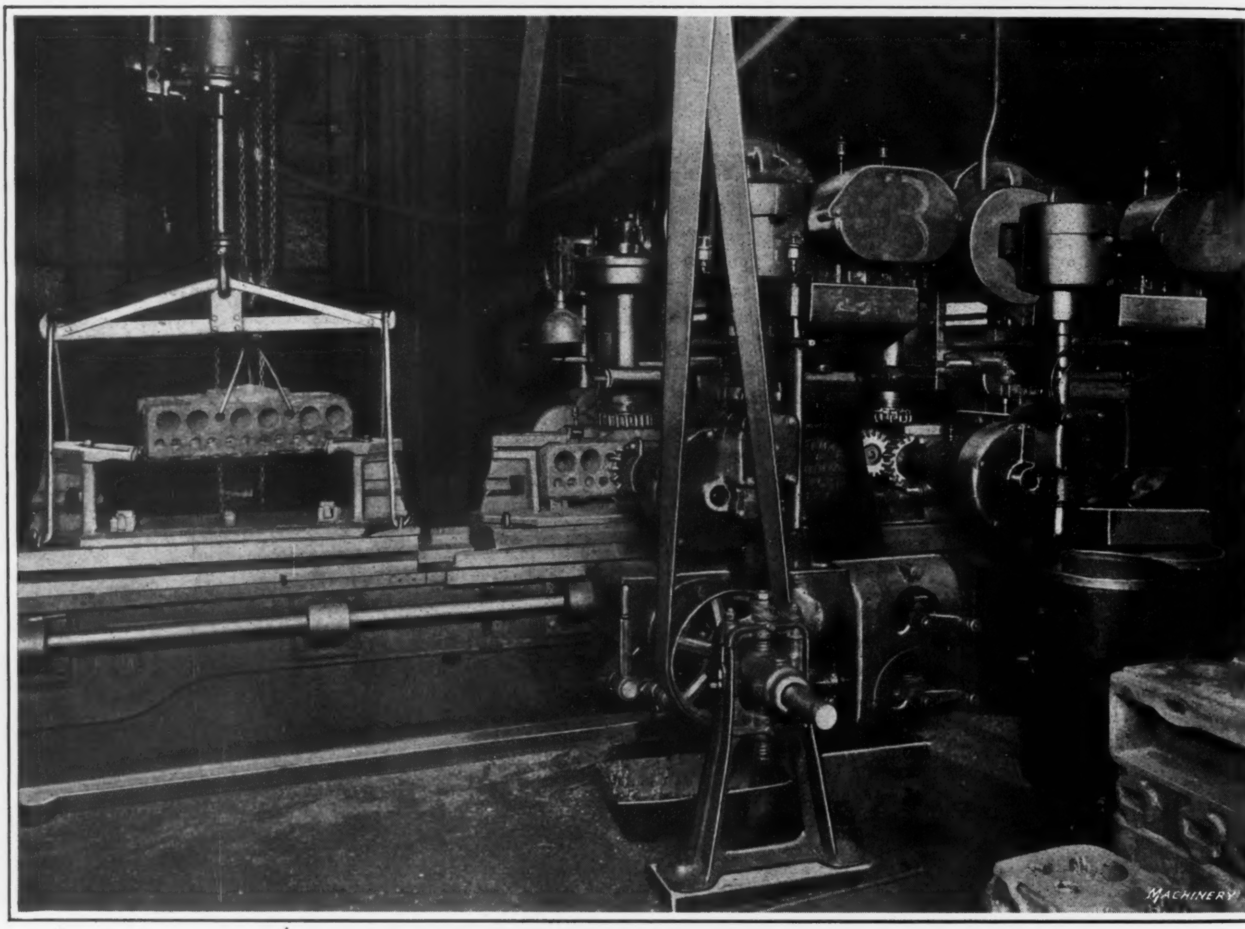


Fig. 12. Complete View of Machine partially illustrated in Fig. 10, showing the Method of returning a Table Section to the Starting Point on the Bed of the Machine

Milling Packard Cylinder Blocks

In machining cylinder blocks for motor cars built by the Packard Motor Car Co., of Detroit, Mich., quite a different

method of procedure is followed from that which has been outlined in preceding descriptions of the work done in several other well-known factories. At the Packard plant, rough cylinder blocks are first delivered to a combination milling and cylinder boring machine built by the Beaman & Smith Co., of Providence, R. I. Two castings are set up on this machine, which is designed in such a way that provision is made for boring four cylinders in one of these castings and simultaneously milling the crankcase face of the other cylinder block casting. After both of these operations have been performed on the work, the castings are transferred to a multiple-spindle drilling machine built by the Baush Machine Tool Co., of Springfield, Mass., which provides for drilling all of the holes that are required in the crankcase face. As soon as this operation is completed on each casting, it is slid off the table of the drilling machine onto a gravity carrier along which the castings run to a Beaman & Smith multiple-spindle milling machine, on which the remaining milling operations are performed on the work. This machine is equipped with four milling cutters so that the seats for the valve chamber cover, the intake manifold, the cylinder block cover, and the exhaust manifold may be milled simultaneously. There is nothing particularly unusual about the equipment of this machine, with the possible exception of the fact that a two-spindle side-head is mounted on one of the housings to provide for driving two cutters used for milling the valve cover seat and the intake manifold seat at different levels.

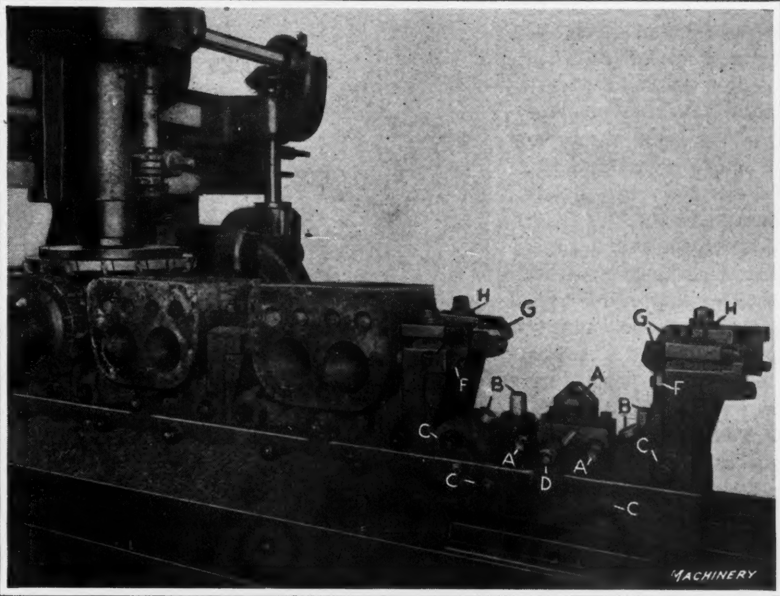


Fig. 13. Opposite Side of Multiple-spindle Milling Machine shown in Fig. 11. This Illustration shows Adjusting Screws on the Fixture

A marked departure from the usual practice has been made in designing the work-holding fixtures used on this machine. Such a departure would naturally be expected, however, when consideration is given to the fact that the cylinder blocks delivered to this machine have been bored and milled on the crankcase face, and that all of the holes have been drilled in this face of the work, while in the case of other cylinder block milling fixtures which have been described, the work is set up on the machine in the condition in which the castings are delivered from the foundry. While drilling holes in the crankcase face of these cylinder blocks, two dowel-pin holes are drilled, which will be utilized in the engine assembling department for lining up bolt holes in the cylinder block and crankcase. Locating pins *A* on the fixture enter these dowel holes when setting up the work on the milling machine shown in Figs. 14 and 15. The usual practice is followed of employing the previously milled surface on the work to support it for the performance of subsequent milling operations, and for this purpose nine finished pads *B* are provided.

The casting is held down at one side by means of two bolts *C*, which pass through holes drilled in the flange of the crankcase face; and at the opposite side there are three straps *D* which bear upon the upper surface of the same flange. All of these clamping members are located at the base of the work, and it is necessary to also afford means of steadying the work to prevent pressure of the cutters applied near the top of the castings from setting up chatter and vibration. This result is attained by providing two split chucks *E* which fit into the bored cylinders at opposite ends of the block. By tightening the nuts located at the top of chucks *E*, tapered blocks inside of these chucks are drawn downward, thus expanding the chucks and causing them to obtain a firm grip on the work. With an equipment of this kind, the fixtures may be loaded with very little loss of time. The work is fed to the milling cutters at a rate of 8 inches per minute and the cutters are geared to give a cutting speed of 60 feet per minute. Operating under these conditions, the rate of production attained is from 45 to 50 cylinder blocks in a nine-hour working day. Four cylinder blocks are set up on the machine for each traverse of the table.

Milling Continental Cylinder Heads

In machining the heads for automobile engines built by the Continental Motors Corporation, of Detroit, Mich., it is necessary to mill the bottom face which is bolted to the cylinder block and also face off the bosses at the top surface of the head. For the performance of these two operations an Ingersoll four-spindle milling machine is used, which is equipped with fixtures of the type shown in Fig. 16. Two

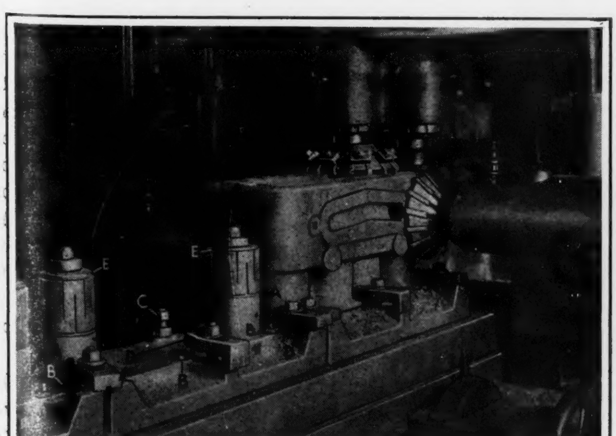


Fig. 14. Work-holding Fixture and Cutters used for machining Packard Cylinder Blocks on Beaman & Smith Multiple-spindle Milling Machine

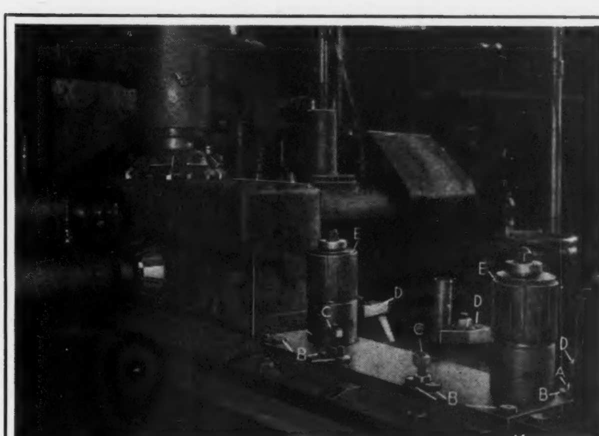


Fig. 15. View from Opposite Side of Multiple-spindle Milling Machine shown in Fig. 14, showing Further Details of Cutters and Fixture

castings are set up on the top of this fixture to provide for facing off the bosses; and after this has been done, the two pieces of work are turned over and bolted to the sides of the same fixture ready for a second operation that provides for milling the lower surface of the head which engages the milled top face of the cylinder block. It is important to provide the required amount of clearance in the combustion chambers of these cylinder heads, and for this reason the work is located by means of two hardened plugs *A* which project up into the combustion chambers. These two plugs are supported at their lower ends by a rocker arm, so that they can adjust themselves for slight variations in the castings. Two other supporting pads *B* rest against the under side of the flange on the work. The castings are held in the fixture between two knurled stops *C* and two knurled straps *D*, the latter also being used to hold the castings on the side of the fixture for the performance of the second operation. In setting up two castings on the top of this fixture for the first milling operation, it is highly important to have the work held down tight against the locating points of the fixture, and assurance that this result is attained is secured by the use of yokes *E* that have a hook at each end which grip pins provided in the fixture for that purpose. Then capstan screw *F* is tightened down onto the work to force it firmly against the locating points of the fixture. When the casting has been located in this way, straps *D* are tightened, and after the work has been set up in this manner, yokes *E* may be removed with perfect assurance that the work will not spring out of place.

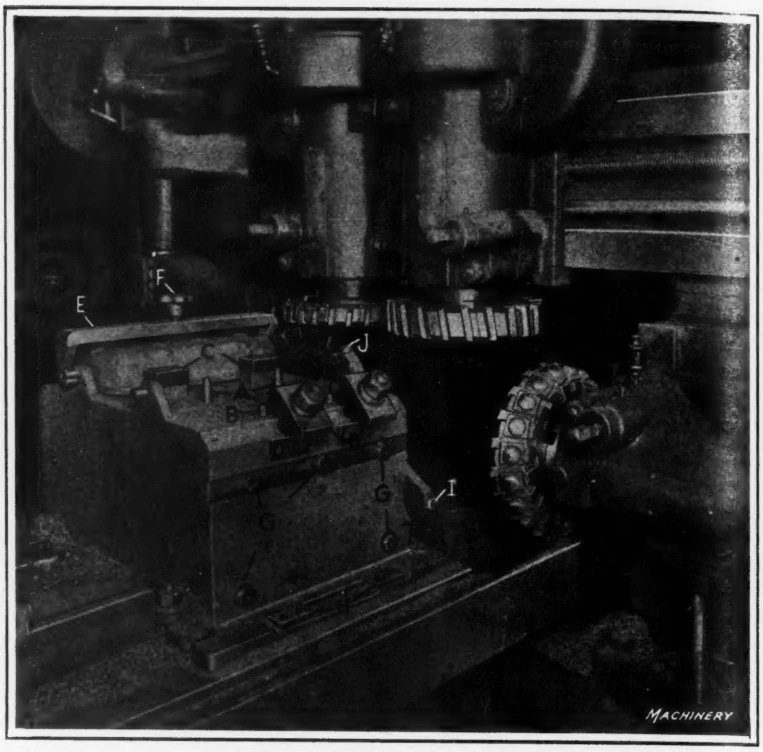


Fig. 16. Arrangement of Cutters and Design of Work-holding Fixture used on Ingersoll Multiple-spindle Machine for milling Continental Cylinder Heads

After the first operation has been performed on castings mounted in the two stations at the top of the fixture, they are set up at the sides of the fixture, location being accomplished from the milled faces of the bosses on the castings, which come into engagement with five fixed stops *G*. As previously mentioned, straps *D* also secure the work at the side of the fixture, these straps forcing the casting down against knurled stops *H*. It will, of course, be quite obvious that each fixture as it passes under the milling cutters is loaded with four cylinder head castings, two of which have the first operation performed on them while the second operation is being performed on the other two castings. Consequently, two cylinder heads are finished as each fixture passes under the cutter. Before leaving the description of this fixture design, attention is called to the fact that there are two setting points *I* and *J* that are used with a "feeling gage" 1/16 inch in thickness for locating the cutters at the time the machine is being set up. This operation is performed at a cutting speed of 102.6 feet per minute, with a feed of 4 inches per minute. The rate of production obtained for the performance of both operations on the cylinder heads is 12 per hour. Two men are employed to load and unload the fixtures.

Milling Hudson "Super-Six" and "Essex" Cylinder Heads

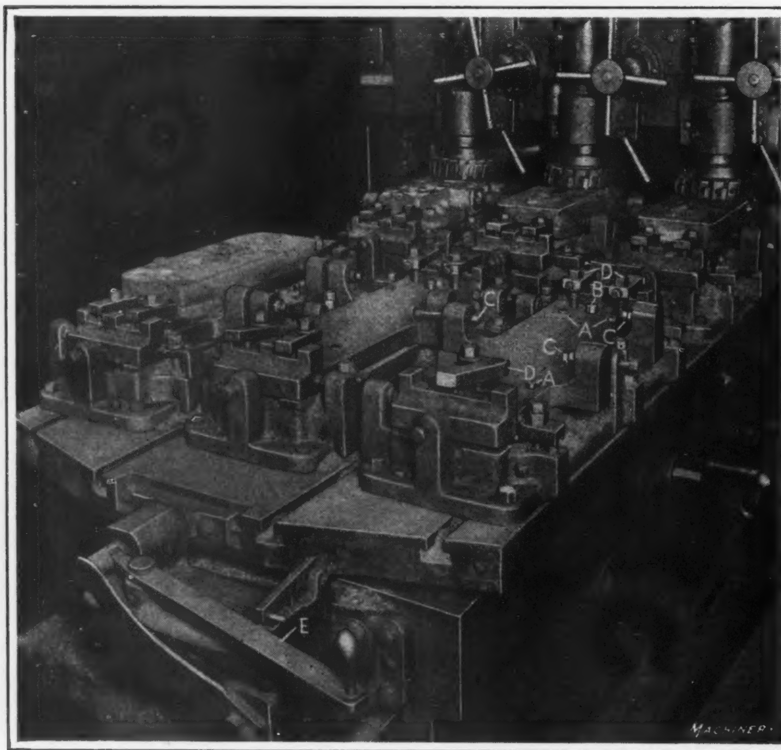


Fig. 17. Beaman & Smith Multiple-spindle Milling Machine equipped with an Indexing Table for milling Hudson Cylinder Heads

For the performance of milling operations on the water-jacketed head of the Hudson "Super-Six" motor, it is necessary to take one facing cut over the top of the head, and a roughing and finishing cut over the surface which comes into engagement with the milled top of the cylinder block. For the performance of these operations, use is made of a special three-spindle Beaman & Smith milling machine which is equipped with an indexing table fitted with six work-holding fixtures. This equipment, which is shown in Fig. 17, has the advantage of allowing milling operations to be performed on three castings carried in the fixtures at one end of the table while the operator is engaged in removing milled cylinder heads and substituting other castings in the fixtures at the opposite end of the table. Then it is merely necessary to withdraw the locking pin and rotate the table through 180 degrees in order to bring the next castings into the operating position. With an equipment of this kind, there is very little idle time of either the machine or its operator.

With this preliminary statement as a basis of discussion, a detailed description can be given of the way in which the machine is operated and the method of setting up castings in the fixtures. It will be apparent that lever

E provides for withdrawing the locking bolt when it is required to index the table to bring the next set of castings into the operating position. The first operation performed on the work consists of milling the top face of one cylinder head, and there are two castings set up on the table for this operation, one of which is shown under the left-hand spindle of the machine, while the other casting will be set up diagonally opposite, that is, at the right-hand end of the front row of fixtures. After this operation has been performed on the top of the casting, it is removed from the first fixture, turned over and set up in the middle fixture of the same row, so that at the next traverse under the cutters it is ready to have the roughing cut taken on its under surface that comes into contact with the top of the cylinder block. Then when the table is again indexed to provide for resetting the work, this casting is moved over to the position shown at the extreme left in the front row of fixtures, and thus is in place for taking the finishing cut. The cutters which perform the roughing and finishing operations on the under side of the cylinder heads, are set at levels which differ by approximately 0.020 inch, so that suitable provision is made for taking a finishing cut of average depth. It will be understood that all three fixtures are loaded before the table is traversed under the cutters, so that the milling of one head is completed for each traverse movement of the table.

The design of the fixtures used for milling opposite sides of these castings is essentially the same. The casting is dropped into place in the fixture, where it is supported by three pads *A*, and a pin *B* provides for carrying the end thrust. Sidewise location of the casting is accomplished by means of three screws *C*, two fixed screws being provided at one side of the fixture and an adjustable screw at the opposite side. For holding the work down in the fixture, use is made of straps *D* which are provided with round-pointed ends to enter the core-support holes in the castings. It will be apparent that at one end of the fixture there are two straps *D*, while at the opposite end there is a strap provided with two points to enter the core-support holes in the work. At one end of the fixture there are compression springs beneath these straps, while at the opposite end the strap is slotted so that the round points may be withdrawn from the core-support holes in the work after slightly loosening the bolts. The milling cutters used for the performance of this operation run at 52 feet per minute, and a rate of feed of 9 inches per minute is employed. On the "Essex" head, the surface milled is 19 by 8¾ inches in size, and on the "Super-Six" the surface to be milled measures 7¾ by 29 inches. The rate of production obtained is 85 cylinder heads in an eight-hour working day.

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DOUBLE AND COMPOUND ANGLES

BY THOMAS A. REILLY

Referring to the article appearing in the March number of MACHINERY, which comments on an article on "Double and Compound Angles" in the November number, the writer wishes to refute a statement made in the second article. This statement reads: "The previous article described the method of laying out compound angles on an elevation drawing, and is not applicable to lay-out work in the shop, as its use is limited to problems encountered in construction drawing."

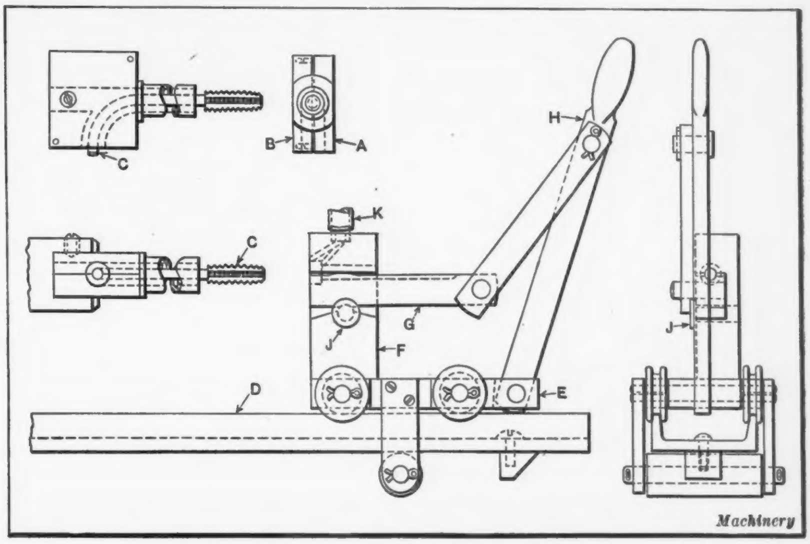
Some years ago the writer was engaged in bench work. Owing to the amount of work requiring the measurement of double and compound angles which was encountered, it was found, by standardizing the method of doing this work as previously explained, that matters were greatly simplified because it enabled one to get down to the solution of the problem immediately. It is not claimed that the method is original or new, but it has been passed on so many times that it was thought worth while to have it become more generally known. Stress is laid upon the fact that it is applicable to any problem of this nature and enables one to work out clearly the necessary figures, with a minimum chance of error.

* * *

BENT NUT TAPPER

BY HOWARD M. BOGART

For tapping large quantities of nuts, the familiar bent-tap method may be used to good advantage. The arrangement that is shown in the accompanying illustration was devised for use in tapping about a million nuts, which were required to have a full sharp thread. The chuck was attached to the headstock of a speed lathe. It consists of the two members *A* and *B*, fastened together as shown, in each of which there is an annular, semicircular groove, forming a hole for holding the bent tap *C*. The headstock is mounted on a channel iron *D*, which also serves as a track on which the rollers of the carriage *E* may travel. The vise *F* is mounted on the carriage, and is actuated by a handle *H* and a toggle-joint lever *G* which fulcrums on stud *J*. The nuts are thus clamped in the vise when the carriage is moved forward by means of the handle, and brought into contact with the end of the tap. Cutting fluid is supplied through the tube *K*, so that the tap and vise are effectually cleared of all chips, which greatly expedites the work.



Device for holding and tapping Nuts by the Use of the Bent-tap Method

In operation, the shank of the bent tap is loaded with tapped nuts, like a magazine, and these support the tap when it is at work. After a nut is placed in the vise and the carriage is moved forward, the continued pressure of the hand on the handle forces the nut over the tap and onto the shank, and simultaneously ejects one nut from the bent end of the tap. Reversing the pressure of the handle returns the carriage and opens the vise for reloading. On work where the quantity of production will warrant its use, the bent-tap method of tapping will save much time.

* * *

The average output per man per year in the coal fields of France before the war was about two hundred and fifty tons, while in the United States it is nearly a thousand. France had a normal coal production of about forty million tons and a consumption of about sixty million tons a year, the balance being adjusted by coal supplied from England and Germany. Seventy per cent of the coal produced in France was obtained from the northern part, which is part of the area captured by the Germans, and the mines in part of this area have been destroyed. Outside of man power, coal will be the greatest need of France for the next few years.

ELEMENTS OF COSTS IN DESIGNING SPECIAL MACHINERY

BY F. E. JOHNSON

The two principal factors that contribute to the initial costs of a machine are design and pattern work. The time consumed for these processes in creating a new machine often exceeds the time consumed in the machine shop for the actual construction work. The machining of parts which are special in character must be done on time work and without the aid of many special tools, jigs, and fixtures.

Costs for designing work and drawings cannot always be estimated with a great degree of accuracy. Much depends upon how the problem is handled, in addition to the amount of special knowledge that the designer from his experience is able to apply to the work at hand, and the nature of the design either complicates or simplifies the problem.

Adapting Standard Designs to Special Machines

In certain cases the various elements or principles of construction for a machine are common. Their practical value for the respective functions for which they are intended is known; therefore the designing work consists largely of adapting them to form a new combination. Machine tool builders, as a rule, have confined themselves to producing machines which adhere to a type and for which there is a universal demand. Such machines may be built in quantities by time-saving and cost-reducing methods. The general demand that has been created during the past few years for machines of great productive capacity has resulted in developing new standard types. The general development of machine tools has tended toward quantity production at the lowest manufacturing costs by means of machines which may be operated by unskilled labor. It has been difficult to secure sufficient skilled workmen to maintain the degree of accuracy generally required in producing the various parts that make up many products; consequently machines must be devised that will give the results and production demanded.

A standard design is a perfected arrangement resulting from experience, and its use will conserve time, expense and effort, and will eliminate the element of uncertainty as to its practical value. For special machinery, generally intended for a single purpose or operation, the work may involve new problems that will result in mechanisms or processes which are in the nature of inventions and for which considerable time may be required to develop practical designs. Work that is special in nature is expensive and time-consuming. In original machine designs, the adapting of standard parts cannot always be extensively accomplished, especially in the early stages of the design.

Factors Affecting the Initial Cost

A perfected arrangement at the outset is practically impossible, for designs must be developed and eliminated until a suitable arrangement is finally decided upon. This procedure is particularly true in the development of small, complicated mechanisms. The first machine is generally a more or less experimental one, and possibilities for reducing its manufacturing costs cannot be determined until its operating principles have been practically demonstrated. The cost of patterns and of machining the parts can best be estimated from developed designs and detail drawings, and the designer's practical knowledge will greatly influence the ultimate costs.

It is evident that conditions and circumstances must govern what the possibilities are for reducing costs by introducing standard parts into the design of the first machine. If in developing the design, the use of such parts or units does not work out in satisfactory proportion to other details, or if it becomes necessary to consume much time in assimilating them into the general construction, then the object of economy is defeated.

An item of expense that is often attached to work of this kind, is added when the problem of design is handled individually by more than one designer. Each man, in turn, as he takes up the work, cannot begin where the preceding designer left off, but must study all the data and details connected with the problem in order to proceed intelligently, and it is nearly always true that changes in various points will result. This causes additional delay and expense.

Cost Reduction by Utilizing Standard Parts in the Design

Sometimes the work of designing a machine will, to some extent, consist of adapting perfected mechanisms or of developing new arrangements which are to be adapted to a standard type. In cases of this kind, it is often possible to utilize standard designs, patterns, and stock parts in producing a new machine. This is particularly true if the concern has previously designed and constructed machines to a great extent for its own use. When the various elements are not entirely unknown, the work of estimating time and costs may be accomplished by comparison with previous records and results. Machines so designed are to a great extent evolutions resulting from experience in producing various parts that make up a product, and consequently have a low percentage of failures.

A study of the operating principles of successful machines and mechanical devices that may be incorporated into the design in question is quite necessary. Costs in certain cases may be materially reduced by purchasing standard parts, such as clutches, gears, racks, pulleys, handwheels, bushings, etc. By developing preliminary designs drawn to a small scale previous to laying out the machine, a designer who possesses knowledge of the general requirements and fundamental principles of machines which are similar to the type that he is to develop, can determine what the possibilities are for assimilating them into the general construction.

The designer who handles a specific problem may be a specialist along certain lines, because of long training in this particular class of work, and is thoroughly acquainted with many of the details involved, such as the manufacturing requirements, machining facilities, special tools which may be utilized, etc. Consequently, the factors involved are such that the work is carried out on an economic basis. Similar standardized conditions will apply to the manufacturer who specializes in a certain line of machine tools, for he can economize in expense and time necessary to construct a special machine if the type required is like his regular product.

Cost of Specially Designed Machines Used for Ordinary Machine Operations

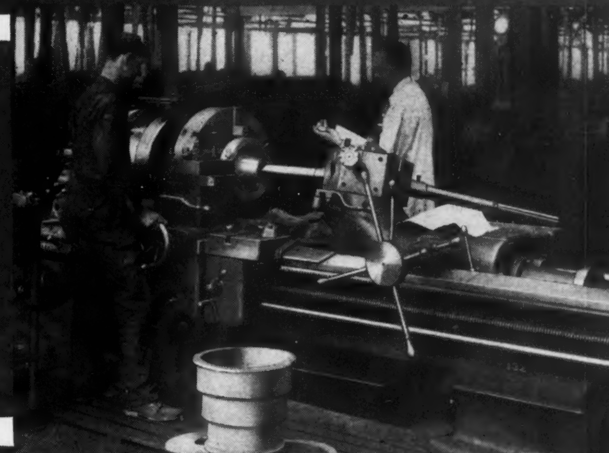
The first costs for a special machine will in many cases determine whether or not it will return a percentage of profit great enough to warrant its construction for some particular purpose. Under other circumstances first costs may be of secondary importance. A new type of machine may be of great benefit because of the possibilities it offers for utilizing unskilled labor. The demand for a product will, in some instances, warrant the expenditure of considerable capital in the prospect of shortening the work and ultimately effecting a saving. In every case, however, the time consumed in designing and constructing a machine will be an important factor, which will control its costs to a great extent, as well as the benefits derived from its use.

Special machines for common shop operations such as drilling, milling, grinding, tapping, turning, etc., as a general rule will not involve new construction principles. In carrying out the design of such machines under conditions where standard designs do not exist, the designer is compelled by necessity to develop the general arrangement throughout. Ideas are drawn from personal experience, precedent, and by collaboration with others who are interested in the project.

It is evident from what has been stated that the design of standard type machines embodying special features is by far the most economical from the viewpoint of initial costs.

Time Study and Rate Setting in a Machine Tool Plant

By ERIK OBERG



A Detailed Review of the Methods Used by the R. K. LeBlond Machine Tool Co., Cincinnati, Ohio, in Making Time Studies and Setting Bonus Rates, together with a Description of the Method by which the Individual Efficiency of Each Man is Recorded

THE object of the system employed by the R. K. LeBlond Machine Tool Co. for studying the time required for performing different operations is to arrive at an equitable basis for the compensation of labor and to make it possible to pay each man in proportion to his individual effort and ability.

Briefly described, the system consists of determining, by means of actual experiments or performance of the work in the shop, an accurate estimate of the time in which it can be done. After this has been done, a "standard time" is set which, in reality, is the maximum time allowed for doing the work. If a man performs the operation in less than the standard time, he will be paid a "premium rate" for each hour or fraction of an hour saved. A "bonus time" is also established which is a certain amount less than the standard time. If a man performs an operation in less than the bonus time his performance is considered exceptionally good and he is paid a "bonus rate" for each hour or fraction of an hour saved; this bonus rate is larger than the premium rate. Furthermore, a record is kept in the form of a chart indicating each man's premium and bonus earnings, this chart being a record of his individual efficiency and value in the plant. The methods whereby the results outlined above are obtained and the details of the system as worked out in the LeBlond plant will be dealt with in this article.

Time-study Methods

When a new job is to be put through the shop, the routing department first issues a routing card, giving the various operations to be performed on the piece, and this card is sent to the time-study department. The time-study man first goes over the routing card to determine if the order of operations or the methods specified for performing them could be improved. In case he believes that improvements are possible, he makes suggestions to the routing department, and after these suggestions have been either adopted or rejected in a conference between the time-study man and the routing man, the actual time study begins.

Fig. 1 shows an example of the sheet used for recording time studies. In this case a time-study is made of the boring and recessing operations on a blank for a composite gear. The sheet contains a drawing of the piece to be made, together with the dimensions. It gives the name of the piece, the identifying piece number or symbol, the lot number to which the piece belongs, the material from which it is made, and the operations to be performed, of which the time study is a record. It further gives the initials of the time-study man, the name of the workman who performed the operations at the machine during the test, the department number in which the time study was made, the machine number on which it was performed, and the date. In other words, it gives a complete record of all the data that may ever be required to determine how and when the time-study test was performed. Whenever possible, the time study is made on the same machine, or at least on the same kind of machine, as will be later used for regularly performing the same operation.

The workman selected for performing the work for the time study should be an average man, neither too fast nor too slow. If it appears that he is working too fast for continuous performance during the time-study test, a note is made of this fact in the space provided for special notes at the bottom of the sheet. The value of the time-study record depends largely upon the harmonious cooperation between the time-study man and the workman. The former must take care not to antagonize the man who performs the work. Should there be any differences of opinion between the time-study man and the man working at the machine, the former should appeal to the foreman rather than attempt to assert any authority of his own.

Speeds and Feeds for Time Study

In performing the time study, it is of importance that the machines be run at the proper speeds and feeds. Some classes of machines are provided with plates fixed to them that show in tabulated form the speeds that are obtainable from the various steps on the cone or from various gear combinations in the speed-box. Many machines, however, are not provided with such tables, in which case the time-study man should provide cards for his department

The methods of time study for the setting of bonus rates based upon a scientific study of the operations to be performed have not been applied to any considerable extent in machine tool plants until quite recently. At the present time, however, a great number of manufacturers of machine tools have evidenced an interest in this subject, it being recognized that the efficiency of the plant can be greatly increased by common-sense methods of time study and rate setting. It is possible to develop a system for this work that does not include all the red tape that is generally thought to accompany scientific management. An example of such a system is found at the plant of the R. K. LeBlond Machine Tool Co.

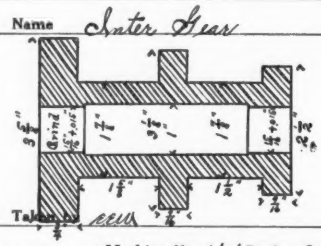
for every machine that lacks such a table, and on these cards should be tabulated the speeds obtainable from the various steps on the cone or from the various settings of the speed-box levers. The time-study man should ask the operator to make all the changes of speeds and feeds and should not do this himself. In determining the highest cutting speeds and feeds allowable, it is better to work from slow speeds upward until the maximum speed has been reached, than to work from too high speeds downward. By following this method there is less likelihood of arousing antagonism on the part of the operator, who naturally would be opposed to the adoption of high speeds and feeds which would prove impracticable. Furthermore, better results can be obtained by using tools and cutters at a safe cutting speed than by overcrowding them, because, when grinding tools too often, more time is lost in regrinding and resetting than is saved by the higher cutting speeds.

In determining the actual time required for the various motions or unit operations, a standard stop-watch is used. When the men know that the object of the time study is merely to place them all on an equitable basis, so that each will receive a just wage, and when they further realize that the method is not used to decrease their wages or unduly speed up their work, no objection will be raised on the part of the men. It is important, however, not to begin time studies in a plant without making the men thoroughly familiar with the object and methods of time study and rate setting, and it is also of importance that the operators be favored in every case where there is any doubt as to the time or rate, so that there never can be any charge of unfairness. The opposition of labor to time-study methods is due largely to the unwise and tactless means by which the method has been introduced in many plants, and also to the fact that it has often been used as a means for favoring the employer only. When the system is installed and employed with a view to benefiting the employer and the employe alike, and when this purpose has been made thoroughly clear to the men, no difficulties are likely to be experienced.

A Detailed Time Study

The time study in Fig. 1 shows the record of four consecutive tests, the time in minutes being recorded in the columns provided, as indicated. The times given are the stop-watch readings after every unit operation and, as the four tests were made continuous, the readings continue from column to column so that the actual time for each unit operation is obtained by subtracting the reading, as recorded, from the next previous reading. After the tests have been made, the average time in which each operation was performed is recorded in the column provided, and minimum times are also recorded where these differ from average time. Then the bonus time is set as indicated in the column headed "Bonus," this time being as nearly as possible equal to the average time except that it is given in round numbers. In the case illustrated in Fig. 1 the bonus time is 7 minutes. The standard time is then determined by adding 40 per cent to the bonus time; hence, in the present case, the standard time will be 9.8 minutes per piece. As indicated, the time-study sheet also gives the speeds and feeds and the tools used. In addition, it gives the set-up time required, which is one of the factors that must be taken into consideration when determining the premium or bonus earnings.

Symbol *DN-6053-S* Name *Inter Gear* Lot No. *2332*



Material *20% Car. C.R.S.* Taken by *E.E.W.* Date *8/2/'18*

Operation *Bore & Recess* Machine No. *164* Dep't. *2* Workman *C. Smith-833*

	Detailed Movements	1	2	3	4	5	6	7	Bonus	Aver.	Mini.	Tools Required: Description and Size	Speed	Feed
1	Pick up & chuck	.40	7.50	14.25	21.20				.40	.35	.30	Universal 3 jaw chuck & steady rest		
2	Clamp steady rest	.60	7.70	14.45	21.40				.20	.20				
3	Index turret & set drill	.85	7.95	14.60	21.80				.25	.262	.15			
4	Center end	1.10	8.15	14.80	22.				.20	.212	.20	Short 1" drill	2nd step 320 RPM	Hand
5	Index turret & set drill	1.30	8.45	15.10	22.30				.30	.275	.20			
6	Drill 43/64"	3.25	10.40	17.10	24.40				2.00	2.00	1.95	43/64" H.S. oil feed drill	80' 320 RPM	.010"
7	Index turret & set bar	3.90	11.	17.65	24.90				.65	.575	.50			
8	Undercut 1" X 3 7/8" long	4.80	11.95	18.60	25.80				.95	.925	.90	3/4" Single point bar 15" long	84' 320 RPM	.010"
9	Index turret & set reamer	5.35	12.30	18.95	26.10				.40	.387	.30			
10	Ream front end 15/16"	5.80	12.80	19.45	26.65				.50	.475	.45	15/16" machine reamer	Slow step 220 RPM	.010"
11	Advance reamer	5.90	12.90	19.60	26.65				.10	.112	.10			
12	Ream rear end 15/16"	6.45	13.40	20.	27.10				.50	.475	.40	Same	55' 220 RPM	.010"
13	Return turret & stop machine	6.60	13.55	20.15	27.25				.15	.15				
14	Release & take out of chuck	7.20	13.95	20.80	27.60				.50	.50	.35			
15									7.					
16														
17														
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32														

Special Notes

Set Up *24 Min.*
Bonus *7. Min.*
Standard *9.8 Min.*

Fig. 1. Sheet used for recording Time Studies

It is of considerable interest to note that previous to a time study having been made of the piece illustrated in Fig. 1, when this piece was made at day rates, the time required for each piece in a lot of fifty was 32.9 minutes. After a time study had been made and the operations properly specified, together with the tooling equipment, it was found that the time required on a lot of fifty was reduced by one operator to less than one-fifth, or 6.2 minutes each.

Compensation under Standard and Bonus Time Systems

Under the system of wage payment used by the R. K. LeBlond Machine Tool Co., every machinist is guaranteed a certain hourly rate, and he receives this rate whether he completes a job in standard time or not. If he completes a job in less than standard time, however, he receives a premium rate, and if he completes it in less than bonus time he receives a bonus rate per hour saved. An example will best illustrate how the system works. Assume that the hourly rate of a man is 45 cents. Assume further that the standard time for 100 pieces is 6 hours 18 minutes. Then the bonus time for 100 pieces would be 4 hours 30 minutes.

First assume that a man requires 7 hours for finishing this job. In that case he would simply be paid his hourly rate of 45 cents an hour, which, for 7 hours would give him a total of \$3.15.

Now assume that the job is finished in 5 hours 3 minutes. In that case the man would be paid his hourly rate for 5 hours and 3 minutes, plus a premium rate for the time saved above standard time. The standard time is 6 hours 18 minutes, and the time saved, therefore, 1 hour 15 minutes. The day rate for 5 hours 3 minutes at 45 cents an hour would give him \$2.27. To this would be added the premium rate for 1 hour 15 minutes. Assume the premium rate to be 24

cents an hour. The premium earned then would be 30 cents, which added to $2.27 gives the man a total of $2.57 in 5 hours 3 minutes, or an hourly rate of about 51 cents.

Now assume that an exceptional man would be able to finish the work in 3 hours 33 minutes. This is nearly 1 hour less than the bonus time, which was set at 4 hours 30 minutes. Hence the man is entitled to the bonus rate for the time saved. The bonus rate is 50 per cent higher than the premium rate, so that with a premium rate of 24 cents an hour, the bonus rate would be 36 cents an hour. In the example used as an illustration, then, the man would receive, in the first place, his hourly rate for 3 hours 33 minutes, and he would then receive the bonus rate for the difference between 6 hours 18 minutes and 3 hours 33 minutes, which is 2 hours 45 minutes. His total earnings in this case would be: Hourly rate (45 cents) for 3 hours 33 minutes, equal to $1.60, plus bonus rate (36 cents per hour) for 2 hours 45 minutes, equal to 99 cents, giving him a total of $2.59, or an hourly rate for the 3 hours 33 minutes that he required to finish the job of about 73 cents.

The figures used in the foregoing example are wholly assumed, but have been employed to illustrate the principle of increased earnings with increased efficiency. It shows how a man may increase his hourly or daily pay by more than 50 per cent by increased application to his work or by inherent natural ability. It shows how the bonus system will pay an exceptional wage for exceptional work.

One of the evils that have tended to prevent the universal acceptance of either piece rates or bonus systems of wage payments has been that employers have too readily reduced the piece or bonus rates when it was found that some one employe would earn an exceptionally high wage under the rates set. The R. K. LeBlond Machine Tool Co. has made it a rule that standard and bonus times and rates, when once established, will be in force for two years, but the provision is made that they may be changed in case the company installs improved machinery and facilities, or devises improved methods or tools. The system of wage payment outlined above has been in force for about eight years, and, as a matter of fact, no rates have ever been changed during the two-year period for which they were established. This is a highly important principle because there doubtless has been no one thing that has more frequently caused unrest and dissatisfaction than the cutting of piece or bonus rates as soon as the men were able to earn good wages.

In setting the bonus time, an effort is made to obtain the kind of finish that will be required by the inspection department. Should it be found, after the bonus time has been set and the work is passing through the shop, that the inspection department requires a better finish than that allowed for by the bonus time determined by the time-study man, a modification will be made in the time to allow a better finish to be obtained.

How the Results of the Time Study are Made Use of in Wage Payment

As soon as the bonus and standard times have been established by the time-study department, the accounting department is given a record of the operation, together with the bonus and standard times, for the purpose of figuring the payroll for the shop.

DN-6053-S Symbol Inter Gear Name

Date 8/2/'18 Set by [illegible]

Bonus and Standard Time have been set for Dept. 2

Operation Bore & Recess

Machine #164 - Universal 3 jaw chuck & steady rest.

Center end -Short 1" drill - 320 RPM - 2nd step - Hand feed

Drill 59/64" - 59/64" H. S. oil feed drill - 320 RPM - 80' - .010" feed

Undercut 1" X 3 1/4" long - 3/4" Single point bar - 320 RPM - 84' - .010" feed

Ream front & rear end 15/16" - Machine reamer - 220 RPM - 55' - 1st step - .010" feed

Set up 24 Min. - Bonus 7. Min. - Stand. 9.8 Min.

FORM 49

Fig. 2. Instruction Card, specifying Type of Machine, Tools, and Equipment required for the Work

DN-6053-S Symbol Inter Gear Name

Date Set by

OPERATION	DEPT.	SET UP	BONUS	STANDARD
Automatic	15	90. Min.	8.2 Min.	11.48 Min.
Bore & Recess	2	24 Min.	7. Min.	9.8 Min.
Hand ream	3	–	1.3 Min.	1.82 Min.
Finish turn	4	12. Min.	4.2 Min.	5.88 Min.
Cut 27 T. Gear	35	24. Min.	11.76 Min.	16.46 Min.
Cut 23 T. Gear	35	18. Min.	8.76 Min.	12.26 Min.
Cut 18 T. Gear	35	18. Min.	7.6 Min.	10.64 Min.
Burr	11	–	2.75 Min.	3.85 Min.
Carbonize & Harden	12			
Sand blast	12			
Grind hole	5	18. Min.	6.5 Min.	9.1 Min.

FORM 48

Fig. 3. Form for recording All Operations performed on a Certain Piece, Departments in which they are performed, and Time allowed

Name C. Smith Week Ending 12/10/'18 Lot No. 6207

Check No. 833 Symbol DN-6053-S Name of Part Inter Gear

Operation Bore & Recess

No. Pcs. in Lot 200 Good Pcs. Finished 199

No. Pcs. Rejected 1 Cause of Rejection Reamed large

Bonus Time for 1 7. Min. Stan. Time for 1 9.8 Min. Set up 24. Min.

Total Bonus Time 23.25 Hrs. Total Stan. Time 32.5 Hrs. Dept. No. 2

	MORNING FROM	MORNING TO	AFTERNOON FROM	AFTERNOON TO	OVERTIME FROM	OVERTIME TO	HOURS	PIECES FINISHED
WED.								
THU.								
FRI.	10			95			8.5	
SAT.	0	50					5	
SUN.								
MON.	0			85			8.5	199
TUE.								
PREVIOUS TIME						Total	22.	

Rate 48	Amount 10.56
Part of Order	
Complete Order	✓
Std. Hrs. Gained	
Bonus " "	10.90
Actual Time	21.60
Total Earned	3.27
Lost Time	
Count & Workmanship Insp't.	J.C.
T. Keep.	G.M.

THE R. K. LEBLOND MCH. TOOL CO. FORM 40 B

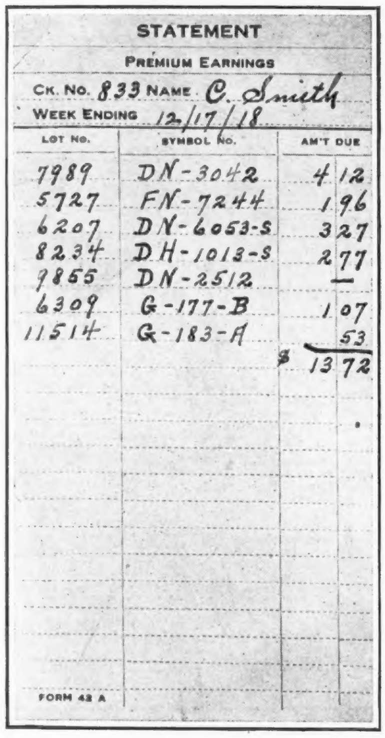
Fig. 4. Premium Time Ticket, giving a Complete Time Record for a Certain Operation

The shop is also furnished with an instruction card covering the operation recorded on the time-study sheet. This card, as shown in Fig. 2, specifies the type of machine and the tools and equipment required for the work, and gives such information as is necessary for properly performing the work. It also gives the time allowed for set-up and the bonus and standard times. This card is kept in a file in the department where the work is done, and the foreman, the operator, and the time-keeper all have access to it.

A form is provided, as shown in Fig. 3, for recording all the operations to be performed on a certain piece, together with the departments in which these operations are performed and the set-up, bonus, and standard times allowed. This card is kept as a record by the accounting department and furnishes the means used by this department in determining wages to be paid.

Fig. 4 shows the premium time ticket which is filled out by the department in which the work is performed and which is returned to the time-study man each week (after passing through the necessary channels in the accounting department for payment of premiums) in order to show how actual performance compares with the time set. Should it prove that on any one operation the workman is constantly requiring more than the standard time, so that he cannot earn any premium, then there will be an investigation of the conditions, and if it is found that the time allowed is too short, a change will be made in the standard and bonus times allowed.

The system also includes a statement from the accounting department of premium earnings, as shown in Fig. 5, which is given to the man each week in his pay envelope, and a form as shown by Fig. 6, which is the inspector's report and which is sent by him to the accounting department authorizing premium payments. The premium time ticket, Fig. 4, is held by the accounting department until the inspector's ticket, Fig. 6, is received, after which the premiums are figured and paid. The reason for holding up the payment until receiving the inspector's report is obvious, because the men are held responsible for spoiled work. They are paid premium earnings on the total number of good parts produced in the total time only, and the value of the time consumed in machining spoiled parts is deducted from the premium earnings.


STATEMENT
PREMIUM EARNINGS
CK. NO. 833 NAME C. Smith
WEEK ENDING 12/17/18

LOT NO.	SYMBOL NO.	AM'T DUE
7989	DN-3042	4 12
5727	FN-7244	1 96
6207	DN-6053-S	3 27
8234	DH-1013-S	2 77
9855	DN-2512	—
6309	G-177-B	1 07
11514	G-183-A	53
		$ 13 72

FORM 42 A

Fig. 5. Statement of Premium Earnings made out by Accounting Department

Permanent Records of Time-study Department

Fig. 7 shows a sheet that indicates how the time-study department records unit times for operations for future use. When a sufficient amount of unit times are thus tabulated, it is not necessary to make a time study in the shop of every operation, but, instead, the bonus times may be taken directly from the records and entered upon the time-study sheet, Fig. 1. This record is made up from past time studies and represents an average of a great many actual observed results. In applying the system there is, of course, an effort made to adopt a standard feed and speed for similar kinds of stock for similar operations, and by recording these speeds and feeds, together with the basic bonus times, as has been done under the heading "Grinding Time" in Fig. 7, it is possible always to specify the speeds and feeds to be used in order to meet the bonus time. These tabulated bonus times save a great deal of time in that they eliminate unnecessary time studies for standard movements and operations.

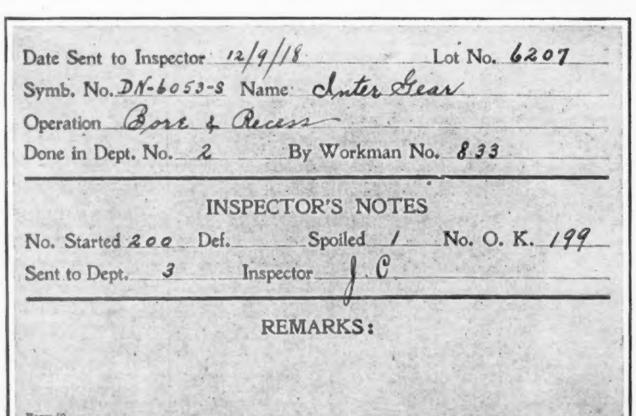
It will be seen by referring to the section devoted to grinding time that by dividing the table according to the character of the stock to be ground and the quality of grinding, as well as with regard to the diameter to be ground, unit times can easily be established. These are for one-inch length of stock, and to find the time required for grinding any length and any diameter it is only necessary to multiply the factor given for a one-inch length, opposite the specified diameter, by the total length of the piece to be ground. Of course, the setting-up and handling time must then be added. It has been found possible to carry the system of time study into the assembling department, so that premium and bonus rates are paid for rapidity in the bench work and other operations in assembling as well.

Record of Individual Efficiency

Fig. 8 shows a chart on which the individual efficiency of every man in the shop is recorded. The diagram has three lines constituting the record. The number of hours gained over standard time is indicated by the full black line. This line is always above the basic line, which shows the standard time allowed for the work. The dotted line shows the number of hours in excess of the standard time. This line naturally will always be below the basic standard-time line. There is also a dash-and-dot line shown, which indicates the value, in dollars, of defective work. It is evident that the highest efficiency is indicated when there is no defective work and no line for hours in excess of standard time, and when, in addition, the full line indicating number of hours gained on standard time comes high above the basic line. By comparing all three factors as they ordinarily would appear on the record, the value of a man to the company may easily be determined.

Special Inducements for Attendance and Punctuality

In addition to the premium and bonus rates paid whenever work is completed in less than standard or bonus time, an attendance bonus of 10 per cent of the total earnings of the employe is paid every three months, providing the employe is neither late nor absent for any reason during that period. Should there be a few instances of lateness or absence due to justified causes, an attendance bonus will still be paid, but the bonus is a smaller percentage of the total earnings. All employes participate in this bonus if their attendance exceeds 90 per cent of the total working hours. During the past year there were eleven employes who had a perfect attendance record for the whole year.


Date Sent to Inspector 12/9/18 Lot No. 6207
Symb. No. DN-6053-S Name Inter Gear
Operation Bore & Recess
Done in Dept. No. 2 By Workman No. 833

INSPECTOR'S NOTES
No. Started 200 Def. Spoiled 1 No. O. K. 199
Sent to Dept. 3 Inspector J. C.

REMARKS:

Form 50

Fig. 6. Inspector's Report which is sent to Accounting Department to authorize Premium Payments

DEPARTMENT NO. 5—BASIC BONUS TIMES

HANDLING TIME			GRINDING TIME					Allowance for Grinding 0.008 to 0.020 Inch	Hardened Stock
		Min.		Diameter, Inches	R.P.M.	Table Feed, Inches	Stock Feed, Inch	Min. Per Inch	Min. Per Inch
	Spring dog	0.06		to 1/2	457	88	0.001	0.20	0.25
Put on dog	Thread dog or driver	0.09		9/16 to 11/16	352	88	0.001	0.23	0.28
	Split or screw clamping dog	0.12		3/4 to 13/16	322	83	0.001	0.25	0.32
				7/8 to 15/16	270	83	0.001 1/4	0.27	0.35
	Soft stock—short lengths	0.09	Grind round steel	1 to 1 1/8	228	83	0.001 1/2	0.28	0.37
Clean centers	Soft stock—long lengths	0.20		1 3/16 to 1 7/16	196	75	0.001 1/2	0.30	0.40
	Hardened stock	0.15		1 1/2 to 1 13/16	160	75	0.001 1/2	0.35	0.45
				1 7/8 to 2 1/16	135	67	0.001 1/2	0.45	0.55
	Short lengths	0.06		2 1/8 to 2 9/16	121	59	0.001 1/2	0.55	0.68
Oil centers	Long lengths	0.08		2 5/8 to 3	100	59	0.001 1/2	0.60	0.75
				to 15/16	270	75	0.001 1/2	0.33	
Grease centers	Heavy parts	0.30		1 to 1 11/16	160	67	0.001 1/2	0.40	
				1 3/4 to 2 5/16	121	59	0.001 1/2	0.50	
	Short lengths by hand	0.10	Grind round cast iron	2 3/8 to 2 15/16	89	51	0.001 1/2	0.60	
Put in machine	Long lengths by hand	0.15		3 to 3 13/16	76	51	0.001 1/2	0.72	
	Large or heavy parts with hoist	0.85		3 7/8 to 4 11/16	59	40	0.001 1/2	0.85	
				4 3/4 to 5 7/16	50	27	0.001 1/2	1.00	
Move table and locate	Small wheel	0.17							
	Large wheel	0.30							
Set stops and locate	Wheel	0.40						Width of Wheel	Width of Wheel
	3" dia. or less—1/16" to 3" long	0.17		1 1/4 to 1 7/16	196		Hand	0.25	0.35
Measure with micrometer	3" dia. or less—3 1/16" to 6" long	0.20	Rough-spot round steel	1 1/2 to 1 13/16	160		Hand	0.30	0.40
	3" dia. or less—6 1/16" to 12" long	0.25		1 7/8 to 2 3/16	135		Hand	0.35	0.48
				2 1/4 to 2 9/16	121		Hand	0.40	0.55

Machinery

Fig. 7. Record of Unit Times for Operations made by Time-study Department for Future Use

HENRY HINDLEY, THE INVENTOR OF THE HINDLEY WORM-GEAR

There have been many different statements made in the engineering press with regard to the inventor of the Hindley worm and gear. In a paper read before the Yorkshire Philosophical Society in England, by John Scott, some interesting information is given, based upon a thorough investigation into original sources. Henry Hindley was a noted clockmaker in York, England. He came to York about 1730, after having served his apprenticeship, it is believed, in Manchester. He died in 1771 at about seventy years of age.

One of his clocks is still in the Guildhall in York, and another in the Lord Mayor's House of the same city. Both clocks are keeping good time after 188 years of service. Another Hindley clock is installed at Clifton Castle. This clock goes for one year with one winding. It shows, besides the time of the day, also the date of the month, and is so arranged that it shows the correct date irrespective of the number of days in each month. It even has a correction for leap years.

Hindley's name has passed down in mechanical history not only as a clockmaker, but also as the inventor of the Hindley dividing engine, which was one of the first devices for accurately dividing a circle into any number of equal parts. In this device, he made use of the worm-gearing which has later been known by his name.

About 1785, John Smeaton, also a York man, wrote a paper to the Royal Society in which he stated that, in the autumn of 1741, he was first introduced to Henry Hindley, who had showed him his dividing engine, "at that time furnished with a dividing plate, with a great variety of numbers for cutting the teeth of clock wheels, and also for more nice and curious purposes furnished with a wheel about 13 inches in diameter, very stout and strong, and cut into 360 teeth, to which was applied an endless screw adapted thereto; the threads of this screw were not formed upon a cylindric surface, but upon a solid, the sides of which were terminated by arcs of circles; the whole length contained fifteen threads, and as every thread on the side next the wheel pointed towards the center thereof, the whole fifteen were in contact together, and had been so ground with the wheel that to my great astonishment I found the screw would turn with the utmost freedom, interlocked with the teeth of the wheel, and would draw the wheel round without any shake or sticking, or the least sensation of inequality."

Further historical information relating to this eminent early mechanic could doubtless be obtained from the Yorkshire Philosophical Society, York, England, or from John Scott, 56 Thorpe St., Scarcroft Road, York, England.

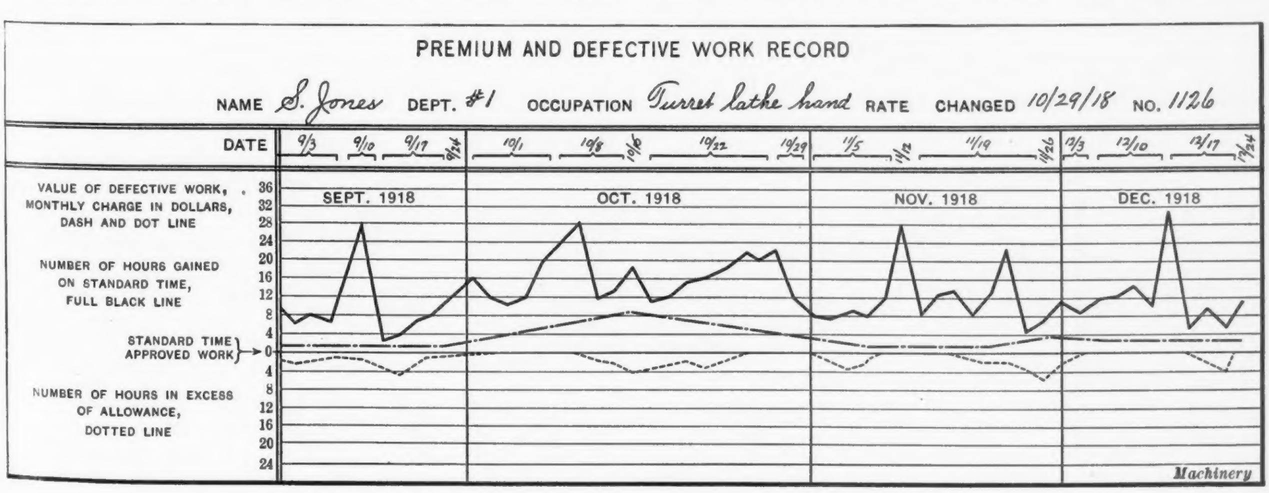


Fig. 8. Chart recording Individual Efficiency of Workmen

Efficiency in the Gage-Making Department

By C. B. Cole

The Operation and Management of a Gage-making Department on a Time- and Money-saving Basis

IN order to maintain an efficient and economical gage-making department, the executive in charge must be thoroughly familiar with the class of work for which his department is required to make gages. He must not only possess executive ability and experience but he must also understand the problems encountered by the workmen in his department and be capable of rendering such assistance as they may require. The assistance required may be in the nature of solving gage-making problems, or in the selection of tools and equipment; but whatever its character the executive should always be ready to assist his workmen with practical advice and help. The men employed on all important work in the gage-making department must not only be careful and expert workmen but they should also be experienced gage-makers who have learned the art of gage-making by actual experience in making gages.

Importance of Complete Equipment in Gage Department

The equipment, lay-out and location of the gage-making department are all factors of great importance. The department should have the best and most complete tool equipment that can be afforded. In some gage-making departments the number of machines available is altogether too small in proportion to the number of workmen. It is preferable for a gage department to be a trifle over supplied with machines than otherwise. When the men have to wait their turn for a machine, time is lost and discipline destroyed. As gage-making requires very close work, it is important that the gage department be so located that good light will be obtained. The most satisfactory location as regards lighting is that in which the majority of the windows face in the direction of the north.

Assignment of Work

Since all men do not have the same ability, it is necessary for the successful executive to know the ability of each individual workman. He can then select men for certain classes of gage work, knowing that these men will be able to complete the work successfully in a reasonable length of time. It naturally requires some time for an executive to determine the class of work for which each man is best adapted, but it is nevertheless good policy for him to endeavor to give his men the work for which they are best fitted. It has been said that a man who hires out as a gage-maker and toolmaker should be able to do any class of gage or tool work, but this attitude does not usually result in attaining efficient and economical production of gages. There are usually a few men in every tool-room who are capable of handling any class of work that may be assigned to them; such men, however, are the exception.

Practical Designs

The executive in charge of the gage department should be consulted by the gage designer on designs that involve difficult gaging problems, so as to eliminate any unnecessary work in making the gage. A gage designer is not always thoroughly practical. In this connection, the writer recalls a certain gage that was designed to have twenty-one gaging points, and was to be made solid, the over-all dimensions being $3\frac{1}{2}$ inches wide, 4 inches long, and $\frac{1}{4}$ inch thick. A practical gage-maker would have seen the serious mistake of designing a gage in this manner. A solid gage having such a large number of gaging points, presents a difficult mechanical problem. One of the objections is that the man making the gage may accidentally spoil it on one gaging dimension, which would mean that the entire gage would have to be remade. Even if the gage-maker successfully completed this gage, it would not be practical for production or inspection purposes, for when any one of the gaging points became worn, the gage would then be useless.

The idea that the gage designer had in mind in designing this gage in one solid piece, was to do away with all operations that he believed to be unnecessary in making the gage as well as in using it. It was the designer's purpose to eliminate lost motion resulting from the necessity of picking up more than one gage, as well as to provide against the workman's forgetting to use one or more of the gages and thereby increasing the chances of scrapping the product. The idea of reducing the number of gages is, however, commendable. The gage finally evolved was composed of several individual units assembled in a solid base, so that if one part of the gage became spoiled, it could be easily replaced with another section, without the loss of the entire gage, thereby saving the cost of a new gage as well as much valuable time.

Selection and Development of the Personnel

The personnel of the gage department should be selected with great care. The executive should personally interview each new applicant and try to judge from his appearance and conversation the qualifications he possesses. A man may be very proficient on ordinary tool work, but he may not

be able to produce satisfactory gages. A personal interview with the applicant would eliminate, in most cases, the possibility of hiring an applicant to do work for which he is not qualified. It was a rather difficult matter during the war to secure the proper men for this class of work, owing to the great shortage of skilled mechanics, and to the fact that prior to the war the number of gage-makers was limited. To meet this demand a considerable number of men had to be trained. It was found that some of the best gage-makers were developed from comparatively young toolmakers who had taken an active interest in shop mathematics. The young toolmakers, as a rule, were ambitious and produced very good results on this class of work.

The great shortage of skilled men also made it necessary to employ specialists in the gage department. These specialists operated milling machines, lathes, drilling machines and grinders, for roughing out gages, etc. Other specialists were developed for cutting threads on thread gages. These men were generally exceptionally skilled lathe hands, who had the necessary amount of patience and a sufficient knowledge of the lathe to enable them to cut very close threads with a perfect finish. By employing these specialists, it was possible to produce gages at a lower cost and in larger quantity than if all the roughing out work had been done by the gage-makers. Apprentices were also used for this roughing out work, and it gave them an excellent opportunity to acquire a trade, and also to become acquainted with different classes of accurate work. Apprentices were also employed for marking and stamping gages, as it is a costly proposition to use skilled men on this work when a boy can be quickly taught to do it satisfactorily.

Care and Use of Equipment

The employment of a reliable man on the power hacksaw in a gage department results in real economy, owing to the saving that can be made by training this man to cut off material without too much waste, and also in training him in the proper use of the hacksaw blades. The amount of loss through unnecessary breaking of these blades and in not moving the vise in the machines so as to obtain the full use of the cutting surface of the blades, may be considerable. A good man on the power saws will also prevent gage-makers from losing hours of time by being obliged to wait for a piece of stock to be cut off. A capable executive will see that the material is cut off and ready to go with the blueprints, whenever he has a man ready to take another job.

If possible, the machine tools that are used by the gage-makers should be set apart for their use only, as this tends to insure accuracy. If required to work to very close limits, a man is usually very careful of the way in which he uses the machine by which he hopes to obtain this accuracy. On the other hand, when these machine tools are allowed to be used by toolmakers or by men from other departments, their accuracy is soon impaired. This is particularly true of bench lathes that are used for small grinding jobs, etc., for too much care cannot be taken to keep these machines up to a high standard of efficiency, as they are almost invaluable in producing good gage work.

The grinding attachments for external and internal work should be cleaned and thoroughly oiled at frequent intervals, and all spindles and fixtures that are made to do special jobs should be kept in a cabinet set aside for this purpose. It is surprising to find the variety of uses that can be made of these special fixtures, with slight alterations, thus lowering the costs in making gages.

The practice of keeping special laps in a proper place, so as to have a record showing the number and size of laps, instead of throwing them into the junk pile and allowing them to accumulate, will result in saving both time and material. If this care is taken, it will be unnecessary for the gage-maker to look around for a piece of stock from which to make a lap, or to requisition material from the stockroom, for in all probability a lap that is suitable for his needs or that can be made so, will be found in the department.

Measuring Equipment

The measuring equipment in a gage department should be of the very best and should be kept checked up to close standards in order to maintain its accuracy. The use of Johansson blocks in a gage department will lower production costs considerably if, instead of following the practice of making size blocks for different jobs, the Johansson blocks are kept where they will be available for use by all the gage-makers. The objection that some concerns have to the use of Johansson blocks is that the cost is very high and that they will become damaged and worn in a short time if the gage-makers are permitted to use them on the benches. However, it is often the case that the cost of making ordinary size-blocks—for which there is generally no further use after the job is finished—in a few months greatly exceeds the cost of a set of Johansson blocks.

The proper marking and stamping of gages before hardening, saves considerable time that would be lost if the gages had to be marked after they were finished. The use of acid for marking finished gages, when not neatly done, detracts from the appearance of the gage. When acid is used carelessly and the finished portions of the gage are not protected by a covering of vaseline, unnecessary work will be caused in removing discolorations caused by the acid fumes, and in some cases it will result in a spoiled gage. In some cases an electric etching machine will be found the most satisfactory means of properly marking gages.

Stock and Production Records for Promoting Efficiency

The rough stock and materials used for making gages cannot always be kept in the sizes wanted. A great saving of time and labor can be effected by having the gage designers confine their over-all dimensions to as near standard sizes as possible, especially on square bar stock or on a standard size of flat stock. In all but the very large factories, a great amount of stock cannot be carried conveniently. In the medium-sized plant, a method which could be used would be to have the drafting department make up a bill of material for the number of gages which are wanted, or which might be ordered, and have this bill of material checked up in regard to the stock available in the factory for making these gages. If this stock were not on hand, it could be ordered in advance, so as to be ready for use when needed. In this way the time and material saved by having this stock as near the sizes required as possible, would be very large.

The keeping of a proper record of all gages that have to be made in the department is very important and tends to promote efficiency in actual production. An index card file for each order of gages that would have to be made in the department is valuable. These cards should contain spaces giving information regarding the receipt of the order, blueprints, material, date started and date completed, and should have proper spaces for use in following up the gage through the various processes in the department. These cards should contain the man's name or other means of identification, and should show the date for which the gage is promised. This data will enable the executive to keep an accurate record of the making of each gage. The information is especially valuable in case it should be rejected by the inspection department, as it gives the executive an idea of the actual time spent in making the gage. This record is also a great aid in determining the priority of the gages, and, in addition, it thoroughly familiarizes the executive with the men in his department.

As the reconstruction problems continue to be settled, more importance will be attached to the gage department than ever before. During the war, it became apparent that the only way in which manufacturers could secure interchangeability and lower the final assembly costs, was by having proper gages and using them correctly. In this respect it will be necessary for the progressive manufacturer either to establish his own gage department or to have gages made by an outside concern that specializes in this class of work.

Tooling Equipment for an Automobile Piston-ring

By THOMAS ORCHARD

THE piston-ring for which the tooling equipment here described was required, is of a very simple type, being merely split on each side and then peened until sprung together. In the process of splitting this type of ring, each side may be milled independently, the last operation breaking the ring. In splitting these rings, an attempt was made to perform both of the operations at one time. This was accomplished by designing a fixture for holding the ring and also a special multiple-spindle milling head having a capacity for holding two cutters.

The design of the special milling head is illustrated in Figs. 1, 2, 3, and 4. The head is placed on the overhanging arm of the milling machine and power is transmitted to it by a shank and coupling on the milling machine spindle, which drives the spindle and cutter *A*. The gear *G*, Fig. 4, on this spindle meshes with an idler gear *B* which, in turn, drives gear *H* on the spindle that carries cutter *C*. It will be seen that Fig. 4 is a sectional view taken through the cutter-spindles and the idler gear spindle. It will also be noted that the gear train is encased in the housing *D* in which suitable bearings are installed to carry the cutter-spindles. The special fixture for holding the ring is clearly shown in Figs. 5 and 6. The piston-ring *R* is placed on a locating plug *P* on the special fixture, which is securely fastened to the machine table. The ring is then clamped in place and fed up between the cutters as illustrated in Fig. 5. With this arrangement the ring is split on both sides simultaneously by simply raising the fixture—a method that is somewhat more rapid than making the fixture stationary and raising and lowering the milling machine table.

The locating plug *P* which carries the piston-ring is dovetailed as shown in the plan view, and the travel is regulated in the dovetailed way of the stand *M*, by operating handle *H*, which is fulcrumed at *O*. The amount of travel of plug *P* is governed by the adjustable stop *S*. The clamp *C*, which holds the piston-ring on the locating plug, must be cut away to prevent any interference with the lower cutter which is directly above the clamp. The correct position of this clamp, which is of the C-type, is determined by a small stop-pin *T*, pressed into the locating plug. After the work has been placed in the fixture and the clamp positioned against the stop-pin, the nut is tightened by means of handle *D*. It should be noted that this nut must be threaded so that the handle will clear the cutter when the work is clamped in position. The arrangement is clearly shown in Fig. 6, which is an end view, looking in the direction of the arrow, Fig. 5.

Owing to the fact that the piston-ring must be completely split in one operation, it was necessary in designing the milling head to drop one cutter below the other in order to eliminate any interference, as shown in Figs. 1 and 3. The same relative position of the cutters must be maintained after grinding; the method of doing this is quite simple, as shown in Fig. 2. The spindles on which the gears and cutters are mounted pass through a plate *E* which may be adjusted from the outside of the case by means of two set-screws *F*. After the cutters have been ground and replaced on their spindles, the lower set-screw *F* is loosened until the cutters are properly adjusted vertically, the top set-screw then being brought down against the adjusting plate and the plate clamped to the inside of the case by means of the nut *N*, Fig. 1. This adjusting is done with the gears always in mesh, the plate swinging on center *K*. The case may contain oil for all the inside mechanism, inlet and drain plugs being provided for this purpose.

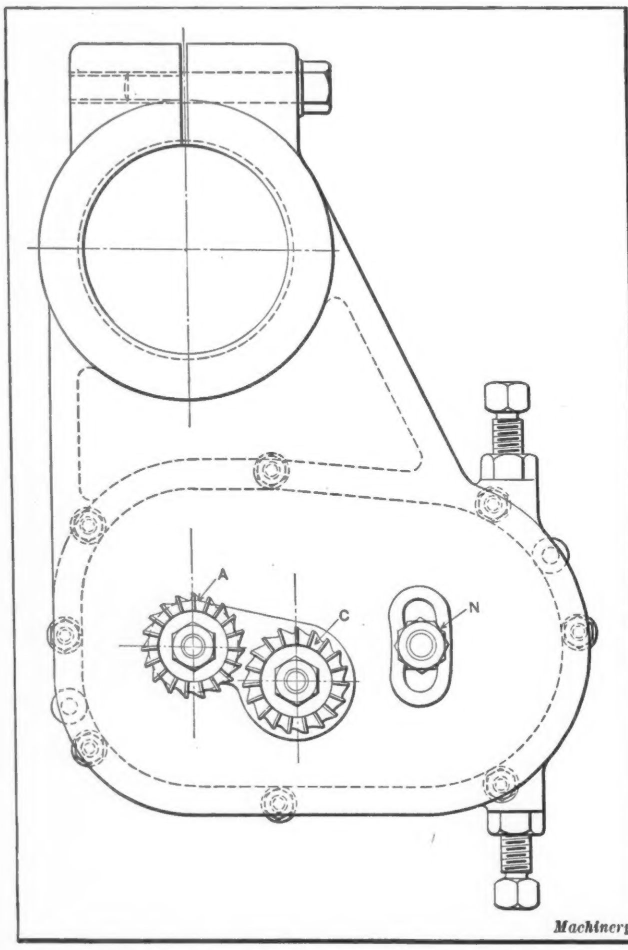


Fig. 1. Multiple-spindle Milling Head for Use in splitting Piston-rings

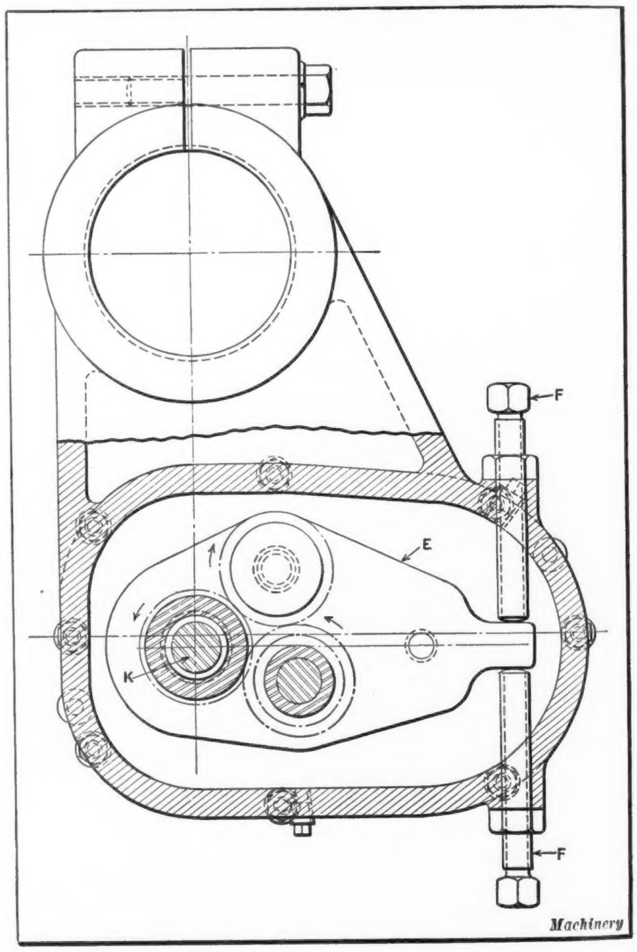


Fig. 2. Sectional View, showing Method of adjusting Cutters

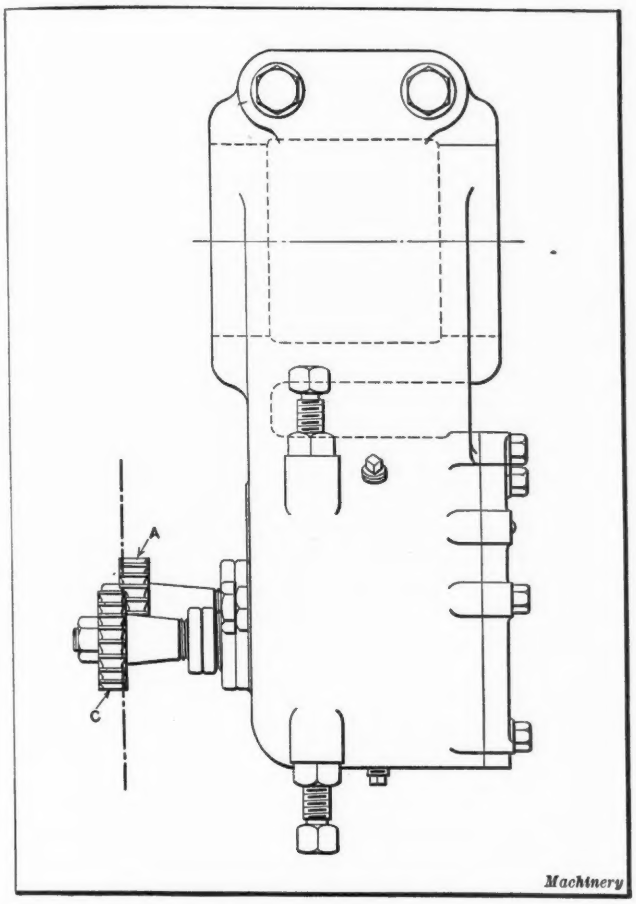


Fig. 3. Side Elevation of the Multiple-spindle Milling Head used for splitting Piston-rings

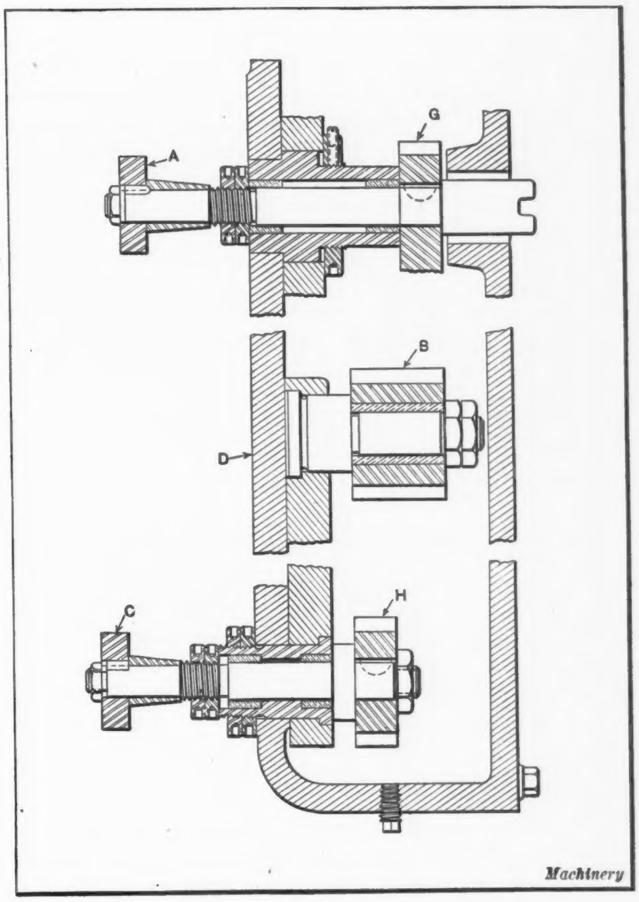


Fig. 4. Sectional View through the Gear Centers, showing Construction of Drive for Two-cutter Milling Head

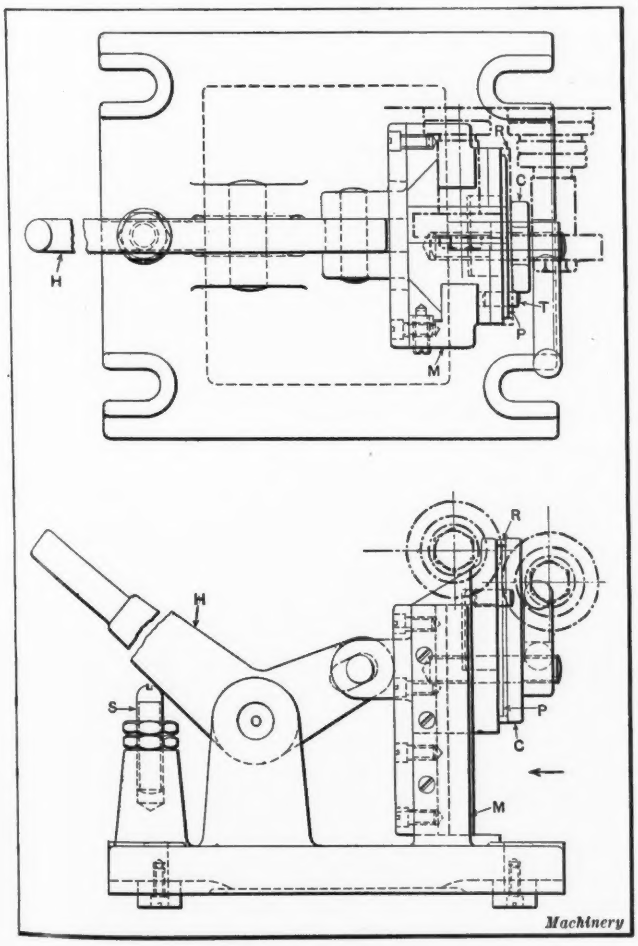


Fig. 5. Plan and Front View of Fixture for holding the Rings during the Splitting Operation, showing Means for locating the Work and Relative Position of Cutters

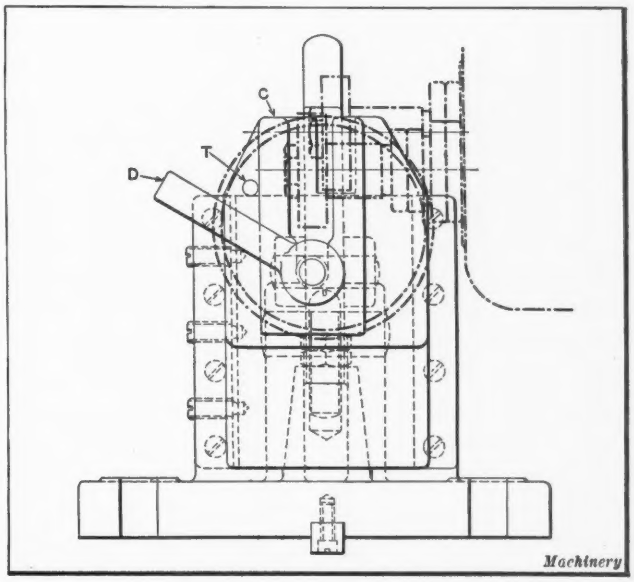


Fig. 6. End View of Fixture illustrated in Fig. 5, showing Clamping Arrangement

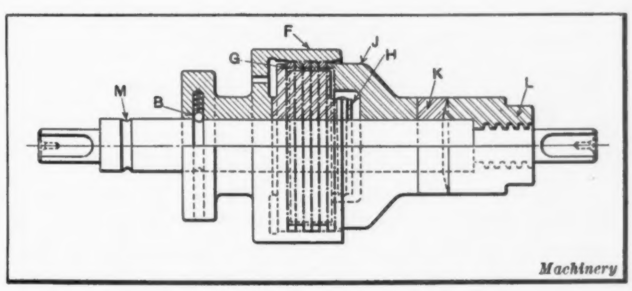


Fig. 7. Arrangement for clamping Piston-rings on Arbor preparatory to grinding. This Fixture provides for holding Six Rings at One Time

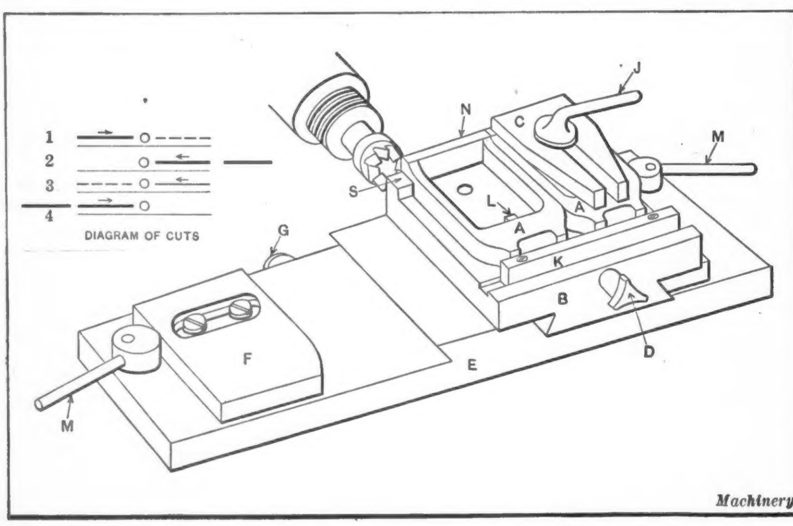
The holding arrangement used for the grinding operation on the piston-ring is shown in Fig. 7. The housing, or collar, *F* is slipped over an arbor, and the rings are sprung into it, against the shoulder *G* on the plug *H*. This plug is held in place on the arbor by means of a tapered pin as shown. After six rings have been sprung into the collar they are secured against the shoulder by means of the clamp *J*. The clamping force is transmitted through a washer *K* by means of the spherical-ended nut *L*. This nut has a coarse Acme thread which is cut away on opposite sides, as are also the threads on the arbor. This arrangement allows the entire clamping device to be removed by a quarter turn of the nut. After the piston-rings are thus securely clamped in position on plug *H*, the rings are exposed for grinding by pulling the housing back on the arbor until the spring-backed ball *B* enters the groove *M*, where this part of the fixture remains until the grinding is finished and another set of rings is ready to be loaded.

* * *

CONTINUOUS MILLING FIXTURE

By DONALD A. HAMPSON

The primary object of continuous milling is to eliminate the loading and unloading time. On some designs this saving of time does not amount to much on account of unavoidable gaps between the work pieces, and the use of large cutters which do not work continuously. An arrangement in which the gaps between the work pieces is practically eliminated and the diameter of the cutter is only slightly larger than is required to cover the work is shown in the accompanying illustration.



Clamping Fixture for Continuous Milling on a Plain Milling Machine

A plain milling machine having a reversible table feed is selected for the operation, which consists of milling the gray iron casting *A* at the end toward the cutter. Previous to milling, the low bearing strip *N* is smoothed off on a disk grinder, and the end which bears against stop *K* is ground to provide bearing surface. Three holders *B* are used, each of which has a capacity for two pieces. The pieces are clamped in the holders by means of the clamp *J* and the slotted strap *C*, this arrangement, of course, being provided for each piece, although only one piece is shown clamped in the illustration. The castings are held securely against stop *K* by means of the handwheel *D*, through the medium of two hook-shaped prongs which extend upward and engage in the opening of the casting. The end of one of these prongs is shown at *L*. Two stops *S* are provided on each holder, one at each end, although only one is required at a time, depending, of course, upon the direction of the horizontal cutter thrust. A slight clearance is allowed between the stops and the work to facilitate loading. The clamping arrangement takes care of the upward and downward thrust of the cutter. The purpose is to keep two of the three holders constantly at work in the machine while the third is being loaded or unloaded on a conveniently located work-table. The illustration shows only one holder in place, and allows a view of the base casting *E* and the dovetail fastening device. The holders are slid in against the stop *G* and locked by means of the slide *F*, which is actuated by the cam-lever *M*. The arrangement allows the holder to be easily changed, and the setting is simple and positive. The cutters are high-speed end-mills, with screw shanks, which is an inexpensive construction and allows the cutters to be changed easily or to be removed when it is necessary to regrind them. The average cut removes about 1/16 inch of metal, and care must be exercised on a wall of such thin section to obtain a good finish and, at the same time, a surface that will be perfectly flat.

The feed is the fundamental factor of the continuous operation; four loads, two for each holder—or a total of eight castings—constitute a cycle of operations. By referring to the diagram of cuts (in which a full line represents a working load and a broken line an empty load), it will be seen that for the first cut two loaded holders are placed in the fixture and the cut taken to the right. After the table has passed the central position as shown at (1), the holder in the advanced position is removed and replaced with a loaded holder. This replacement takes place, of course, while the cut is being taken on the work in the other holder, and when the table has arrived at the extreme end of its travel the feed knocks off and it is necessary to stop the machine while a loaded holder is placed in the position nearest to the cutter (see cut No. 2). The feed is then thrown in and the table starts in the reverse direction for taking the second cut. When the table has again arrived in the central position, shown at (3) the operator feeds the work by hand across the narrow stop *S* and onto the work in the second holder. While the cut is being taken on the work in this holder, the other holder containing the finished pieces is removed and replaced so that at the completion of the fourth cut (see diagram) it will be necessary to stop the machine again and replace the holder nearest to the cutter. A cycle of operations has now been completed and eight pieces have been machined. It will be noted that only two short stops were required, one at the right-hand and the other at the left-hand extreme travels of the table for the purpose of replacing the loaded holder. This arrangement permits the operator to perform hand operations on the castings while the machine is in operation, or if the quantity of work requires, one man can easily operate several machines. Ample time is available for reloading and unloading the extra holder, which is done on the auxiliary working table.

The loading time loss is very slight, the cutter-on and cutter-off loss amounting to about eight times the diameter of the cutter per cycle, which is not great when the small diameter and consequent high speed of the cutter is considered. No trouble is experienced with clogging chips, as they drop clear of the holders and leave them free from this objectionable feature. For the quality of work required, this device gave better results than any other method and produced more than the standard continuous milling methods that were previously tried. The actual time devoted to milling was small and would compare favorably with that required on a special machine designed for this purpose; in addition the initial investment was very small.

* * *

The Bureau of Labor Statistics, Department of Labor, Washington, D. C., announces that the wholesale prices in the United States of all commodities in September, 1918, were 107 per cent over the average for the year 1913. In Canada, the greatest rise was 115 per cent over the figures in 1913; and in the United Kingdom, 133 per cent above the 1913 average. In France, the increase was 235 per cent.

Combined Stresses

By VICTOR M. SUMMA, Examining Engineer, American Brake Co., St. Louis, Mo.

RANKINE'S formulas[1] for the composition of tensile or compressive stress S, and of shearing stress S_s, acting simultaneously and normally to each other on the same particle of a strained body, are:

$$P_1 = 1/2\ (S + \sqrt{S^2 + 4S^2_s}) \text{ and } P_2 = 1/2\ \sqrt{S^2 + 4S^2_s},$$

in which P_1 is the maximum resultant effect in tension or compression, and P_2 that in shear.

These general and fundamental equations of Rankine can be made to assume various forms, which are often easier to use, though more limited in application. Two of them are the well-known formulas for bars of circular section subjected to combined bending moment M, and twisting moment T, as given in the following:

Equivalent bending moment $M_e = 1/2\ M + 1/2\ \sqrt{M^2 + T^2}$

Equivalent twisting moment $T_e = M + \sqrt{M^2 + T^2}$

These formulas, it must be remembered, give only the maximum tensile or compressive stress. There are also two more (not as well known, though just as important), giving the maximum shearing stress, as follows:

Equivalent bending moment $M_{es} = 1/2\ \sqrt{M^2 + T^2}$

Equivalent twisting moment $T_{es} = \sqrt{M^2 + T^2}$

In this article Rankine's general equations are applied to the special cases of square and rectangular bars, as it is believed that the formulas thus derived will find useful applications in connection with offset levers and brake beams.

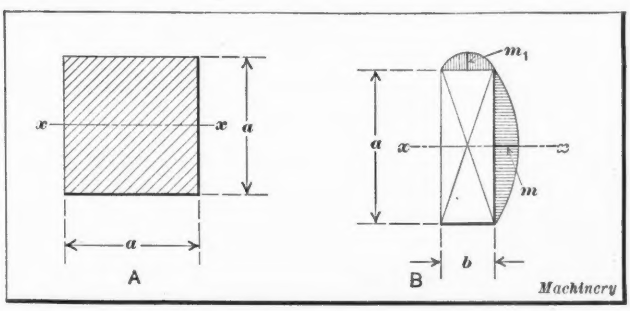


Fig. 1. Diagram for obtaining Plain and Polar Modulus of Section in Square and Rectangular Bars

Square Bars

The section moduli for square bars, as shown in Fig. 1 at A, are $Z = \dfrac{a^3}{6}$ and $Z_p = \dfrac{2}{9}\ a^3$, Z being the rectangular or plain modulus of section, and Z_p the polar modulus of section. Then, calling, as usual, M and T the bending and twisting moments, respectively,

$$S = \frac{6M}{a^3} \text{ and } S_s = \frac{9T}{2a^3}$$

Substituting these values in the formula $P_1 = 1/2\ (S + \sqrt{S^2 + 4S^2_s})$, we have:

$$P_1 = 1/2\left(\frac{6M}{a^3} + \sqrt{\frac{36M^2}{a^6} + \frac{4 \times 81\ T^2}{4a^6}}\right) =$$

$$1/2\left(\frac{6M}{a^3} + \frac{1}{a^3}\sqrt{36M^2 + \frac{36 \times 81T^2}{36}}\right)$$

$$P_1 = 1/2\left(\frac{6M}{a^3} + \frac{6}{a^3}\sqrt{M^2 + 2.25T^2}\right) = \frac{3}{a^3}(M + \sqrt{M^2 + 2.25T^2})$$

$$P_1 = \frac{M + \sqrt{M^2 + 2.25T^2}}{\dfrac{a^3}{3}}$$

Dividing the terms of this fraction first by 2 and then by 9/2, we have:

$$P_1 = \frac{1/2\,M + 1/2\,\sqrt{M^2 + 2.25T^2}}{\dfrac{a^3}{6}} = \frac{1/2\,M + 1/2\,\sqrt{M^2 + 2.25T^2}}{Z} \quad (1)$$

and

$$P_1 = \frac{2/9\,M + 2/9\,\sqrt{M^2 + 2.25T^2}}{\dfrac{2}{9} \times \dfrac{a^3}{3}} = \frac{2/3\,M + 2/3\,\sqrt{M^2 + 2.25T^2}}{Z_p} \quad (2)$$

Also since the value of P_2 in the original equations is equal to P_1 minus the term outside the radical, it can be written:

$$P_2 = \frac{1/2\,\sqrt{M^2 + 2.25T^2}}{Z} \quad (3)$$

$$P_2 = \frac{2/3\,\sqrt{M^2 + 2.25T^2}}{Z_p} \quad (4)$$

Rectangular Bars

In cases of rectangular members, it must be remembered that the polar modulus of section shown in Fig. 1 at B has two values, namely, $Z_p = 2/9\ ab^2$, or $2/9\ ba^2$, depending upon whether the fibers under examination are those along side a or along side b. In the illustration, the normal lines to these sides, which are limited by them and the two parabolas, represent stresses at the points where the normals are raised, and the segments m and m_1, their greatest values, corresponding respectively to $2/9\ ab^2$ and $2/9\ ba^2$.

Also, since the modulus of section for flexure is $Z = \dfrac{ba^2}{6}$, and the extreme horizontal segment at the foot of m_1 is the maximum stress corresponding to it, it is easily seen that the maximum combined effect occurs at the middle of sides b. In other words, the moduli of section from which the stresses S and S_s are to be figured are $Z = \dfrac{ba^2}{6}$ and $Z_p = 2/9\ ba^2$; or,

$$S = \frac{6M}{ba^2} \text{ and } S_s = \frac{9T}{2ba^2}$$

Now, by comparing the stresses thus obtained with those for square bars, it is found that the only difference is in the denominators. Therefore, if in Formulas (1), (2), (3), and (4), ba^2 is substituted for a^3, the following equations are obtained:

$$P_1 = \frac{1/2\,M + 1/2\,\sqrt{M^2 + 2.25T^2}}{\dfrac{ba^2}{6}} = \frac{1/2\,M + 1/2\,\sqrt{M^2 + 2.25T^2}}{Z}$$

$$P_1 = \frac{2/9\,M + 2/9\,\sqrt{M^2 + 2.25T^2}}{\dfrac{2}{9} \times \dfrac{ba^2}{3}} = \frac{2/3\,M + 2/3\,\sqrt{M^2 + 2.25T^2}}{Z_p}$$

$$P_2 = \frac{1/2\,\sqrt{M^2 + 2.25T^2}}{Z} = \frac{2/3\,\sqrt{M^2 + 2.25T^2}}{Z_p}$$

which are the same as the formulas for square bars.

[1]See also MACHINERY, August, 1914, "Compound Stresses"; March, 1916, "Formulas for Combined Bending and Torsional Stresses"; December, 1917, "Combined Twisting and Bending Moments"; and April, 1918, "Twisting and Bending Moments in Square and Rectangular Bars."

Thus, care being taken in distinguishing between the values of Z_p for rectangular sections, and of Z_p for square sections, we can write, in general, the following expressions for the maximum stresses of both:

$$P_1 = \frac{1/2\,M + 1/2\,\sqrt{M^2 + 2.25T^2}}{Z} = \frac{2/3\,M + 2/3\,\sqrt{M^2 + 2.25T^2}}{Z_p}$$

= maximum unit stress in tension or compression

$$P_2 = \frac{1/2\,\sqrt{M^2 + 2.25T^2}}{Z} = \frac{2/3\,\sqrt{M^2 + 2.25T^2}}{Z_p} =$$

maximum unit stress in shear

Example 1—A square shaft is subjected to a bending moment of 100,000 inch-pounds and at the same time to a torsional moment of 80,000 inch-pounds. Find the size of the cross-section required to withstand the combined moments safely, assuming the working unit stresses of the material as 12,000 pounds per square inch in tension and 9600 pounds per square inch in shear.

Let a be the side of the required square. Then, $Z = \dfrac{a^3}{6}$ which, by substituting with the other values for P_1, gives:

$$12{,}000 = \frac{50{,}000 + 1/2\,\sqrt{100{,}000^2 + 2.25 \times 80{,}000^2}}{\dfrac{a^3}{6}}$$

Hence,

$$a^3 = \frac{300{,}000 + 3\,\sqrt{10{,}000{,}000{,}000 + 14{,}400{,}000{,}000}}{12{,}000}$$

$$a^3 = 25 + \frac{\sqrt{24{,}400}}{4} = 25 + 39.05 = 64.05$$

Therefore $a = 4$ inches.

Similarly, as it was specified not to exceed 9600 pounds per square inch in shear, we must ascertain what value a would take in such a case.

Thus, by using the first expression for the value of P_2:

$$9600 = \frac{1/2\,\sqrt{100{,}000^2 + 2.25 \times 80{,}000^2}}{\dfrac{a^3}{6}}$$

Hence,

$$a^3 = \frac{3\,\sqrt{24{,}400{,}000{,}000}}{9600} = \frac{3 \times 1562}{96} = 48.8$$

Therefore $a = 3.66$ inches, which shows that the side of the required shaft must be 4 inches, as found by the first assumption.

Example 2—An ordinary lever, as shown at *C*, Fig. 2, has an offset equal to 3 inches. Assuming the data to be as shown in the illustration, it is required to find the stresses at sections A–A and B–B.

For section A–A, $M = 8000 \times 10 = 80{,}000$ inch-pounds; $T = 8000 \times 3 = 24{,}000$ inch-pounds; and $Z = \dfrac{1 \times 6^2}{6} = 6$; $Z_p = \dfrac{2}{9} \times 1 \times 6^2 = 8$.

Then, using either one of the two expressions for P_1 and P_2, we have, by substitution:

$$P_1 = \frac{40{,}000 + 1/2\,\sqrt{80{,}000^2 + 2.25 \times 24{,}000^2}}{6}$$

$$P_1 = 6666 + \frac{1000\,\sqrt{80^2 + 2.25 \times 24^2}}{12}$$

$$P_1 = 6666 + \frac{1000 \times 87.8}{12} = 6666 + 7317 = 13{,}983 \text{ pounds}$$

per square inch in tension or compression.

Using the second expression, in conjunction with $Z_p = 8$, we have:

$$P_1 = \frac{2/3 \times 80{,}000 + 2/3\,\sqrt{80{,}000^2 + 2.25 \times 24{,}000^2}}{8} = 13{,}983$$

pounds per square inch.

Similarly, for the maximum unit shear, we would have:

$$P_2 = \frac{1/2\,\sqrt{80{,}000^2 + 2.25 \times 24{,}000^2}}{6} = \frac{1000\,\sqrt{80^2 + 2.25 \times 24^2}}{12}$$

= 7317 pounds per square inch

Consider now the section at B–B. In this connection let us assume that the arms for the moments of the 8000 pounds per square inch force with respect to the plane of cross-section B–B and of axis X–X perpendicular to it at its center of gravity are as shown at *D*, Fig. 2; then we have: $M = 8000 \times 5 = 40{,}000$ inch-pounds; $T = 8000 \times 1 = 8000$ inch-pounds; and $Z = \dfrac{1 \times 4^2}{6} = \dfrac{8}{3}$; $Z_p = \dfrac{2}{9} \times 1 \times 4^2 = \dfrac{32}{9}$

Hence, as before:

$$P_1 = \frac{20{,}000 + 1/2\,\sqrt{40{,}000^2 + 2.25 \times 8000^2}}{\dfrac{8}{3}}$$

$$P_1 = \frac{3 \times 20{,}000}{8} + \frac{3}{16} \times 1000\,\sqrt{40^2 + 2.25 \times 8^2}$$

$P_1 = 7500 + 7830 = 15{,}330$ pounds per square inch in tension or compression.

Similarly, $P_2 = 7830$ pounds per square inch in shear.

From these two examples it will be realized that there is a broad field of usefulness for these new formulas; and since they are so much like those for circular bars, they may be given in the following table in a convenient form:

Members Subjected to Combined Bending and Twisting Moments

Circular Sections

Equivalent bending moment (for tension or compression):

$$M_e = 1/2\,M + 1/2\,\sqrt{M^2 + T^2}$$

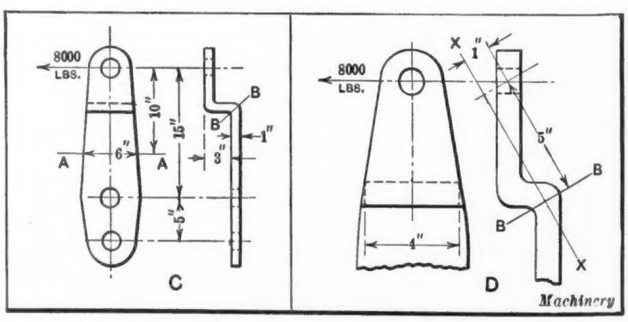


Fig. 2. Example of Combined Stresses in Offset Lever

Equivalent twisting moment (for tension or compression):

$$T_e = M + \sqrt{M^2 + T^2}$$

Equivalent bending moment (for shear):

$$M_{es} = 1/2\,\sqrt{M^2 + T^2}$$

Equivalent twisting moment (for shear):

$$T_{es} = \sqrt{M^2 + T^2}$$

Of these formulas, those for the equivalent bending moment are much easier to apply, and of course should have preference over those for the equivalent twisting moment.

Square and Rectangular Sections

Equivalent bending moment (for tension or compression):

$$M_e = 1/2\,M + 1/2\,\sqrt{M^2 + 2.25T^2}$$

Equivalent twisting moment (for tension or compression):

$$T_e = 2/3\,M + 2/3\,\sqrt{M^2 + 2.25T^2}$$

Equivalent bending moment (for shear):

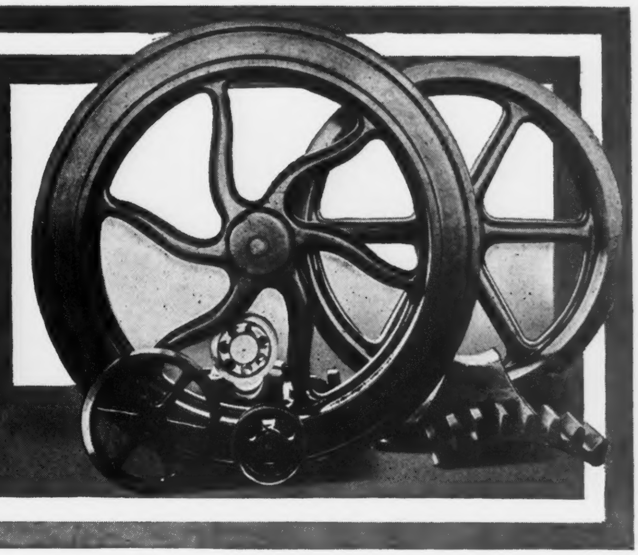
$$M_{es} = 1/2\,\sqrt{M^2 + 2.25T^2}$$

Equivalent twisting moment (for shear):

$$T_{es} = 2/3\,\sqrt{M^2 + 2.25T^2}$$

Wheel Patterns

By Joseph A. Shelly



The Making of Patterns for Webbed and Flanged Wheels as well as for Wheels with Arms—Methods Used for Molding Wheels without Complete Patterns

THE making of patterns for wheels of different designs is a common job in pattern shop work. There are two general classes of wheels; one has the plate or solid center and is called a webbed wheel, and the other has spokes or arms. In the web design, holes are sometimes cut through the web to decrease the weight of the wheel, and armed wheels of wide face are frequently provided with a double set of arms; the latter type of wheel, when it is made very long, is generally called a drum.

Webbed Wheels

In building webbed wheels with segment rims, as is the usual practice, the segments should run in continuous courses to form the face, a recess being turned in the central course to receive the web which is circular in form. This construction is to prevent the end and side wood of the web from projecting through the rim and causing under-cuts or projections as the result of the shrinkage of the web. Wide webs are often put together with open joints to counteract the effects of expansion and contraction. The web should fit the recess turned to receive it and should be glued and nailed in place as at *A*, Fig. 1, and the segments should be continued to make the full width of the face, as shown at *B*. The exposed side of the wheel is turned to size both inside and out; it is then rechucked and the cope side is finished with a recess turned to receive the loose cope hub as shown at *C*. This forms a thick edge on the cope hub, which is not easily broken.

If there are to be ribs, those on the cope side should be loose (not attached to the hub) and a dowel-pin put through one of the ribs to keep the cope ribs in line with those on the drag side. These ribs are sometimes checked into a turned hub as at *A*, Fig. 2, but this does not always make a strong job. If there are four ribs, it is preferable to halve them, and if more than four, they may be extended to the center and the hub formed by filling in the corners with blocks running the opposite way of the grain as illustrated at *B*, *C*, and *D*. With the exception of the case shown at *A*, these methods do not provide fillets where the hub joins the web, and none of them provides fillets where the ribs join the web or at the inside of the rim at the rib ends. The fillets are often left to the molder, but if they are required on the pattern, the hub fillet will have to be turned as a raised boss, and pieces will have to be fastened to the web and the inside of the rim to form them as shown at *A*, Fig. 3. The grain of the wood is usually made to run in the direction indicated in the illustration; the fillets are sometimes fastened to the loose ribs and lift away with them, but this results in feather edges and is not satisfactory. When the ribs are very long, they are sometimes kept in the proper position by being tongued into the fillet pieces at the ends as at *B*. The groove should be given plenty of taper so that the loose cope will lift away freely.

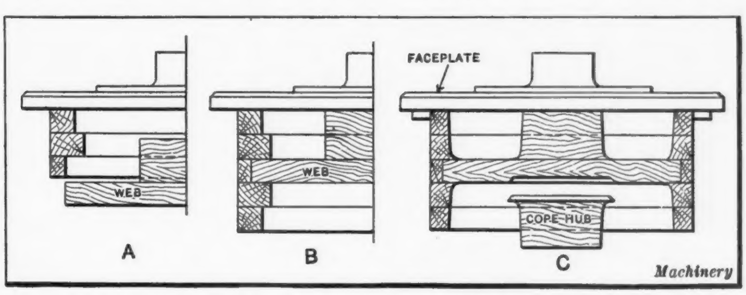


Fig. 1. Method of constructing a Webbed Wheel Pattern

Flanged Wheels

A wheel with a flange on one edge is built in the same manner as a straight-faced wheel, except that the segment courses for the flanges should be made larger to form the flange, which should be in two courses to give strength. If the flange is very thin, a single course with splined joints will make a good job. If the wheel has flanges on each edge, however, it will have to be built differently, as such wheels are usually made in a three-part flask, and the pattern will have to be parted accordingly. There are three ways in which this may be done. The first way is by parting the pattern through the center of the web as at *A*, Fig. 7, a pin being turned in the cope half and a recess for the pin in the drag; this is the usual method of making sheave patterns (see view *B*) and link-chain wheel patterns. The second way is to leave the web solid and turn a rabbet to the rim center to receive the cope side, as shown at *C*. The third plan is to make one of the flanges a loose ring as at *D*. These different methods all have their advantages. Method *A* is usually chosen for small wheels, and those turned from solid pieces are always made in this way.

Coring is another method of making flanged wheels, sheaves, and chain wheels. It has the advantage of giving a solid pattern that is easy and cheap to construct, and is perhaps the better way of doing the job if the face of the pulley or the groove in the sheave is to be machined. A core-print is built on the rim of the pulley or sheave as shown by the dotted lines at *B*, Fig. 7. The print should

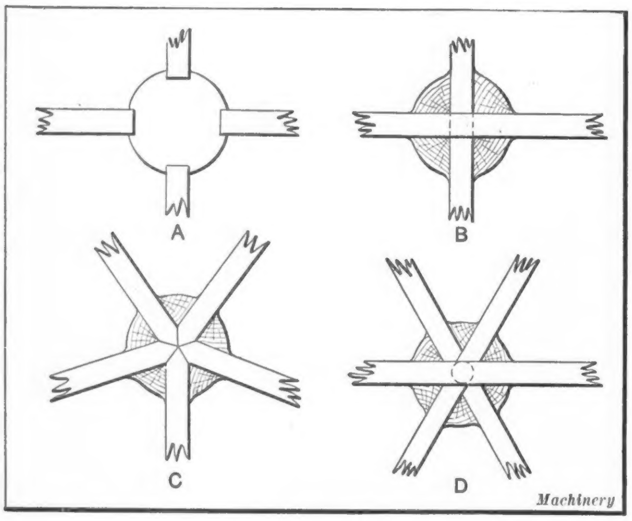


Fig. 2. How Ribs may be fitted to Hub

extend to the center of the round edge of each flange, and the core-box *E* should be a segment that divides the print into equal parts. For a sheave, the segment or part core is made in halves which must be pasted together to complete each part or section. This is the most economical method, although each segment may be made complete by a full box parted through the center or by forming one half of the core with a strickle. The core-print should project beyond the rim far enough to balance that portion of the core that projects into the mold.

Wheels with Arms

When making patterns for armed wheels, which are those having spokes radiating from the center, the spokes are worked to form usually before they are assembled, and are fastened to the rim by being built in during the turning process or after the rim is finished. The assembled arms are called a "spider," and there are a number of ways of fastening them together at the hub or center.

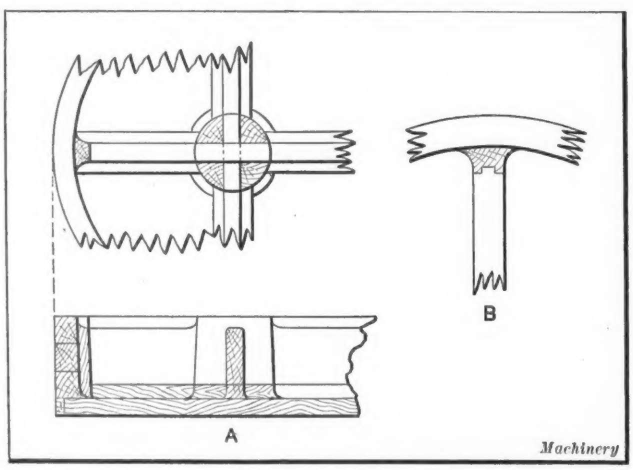


Fig. 3. Methods of forming Fillets

Hub Joints for Spiders

In making spiders, the stock must be wide enough to make the fillets in the corners near the hub and also where the arms join the rim. If a four-armed spider is required, it is usually made of two pieces with a cross-lap joint at the center as at *A*, Fig. 5, but care must be exercised not to make the shoulder joints too tight a fit, as there is likelihood of springing the stock away from a straight line. If the spider is to have six arms, these may be made of three pieces of stock joined at the center in the following manner: The face side of each piece is marked and the lines for checking are laid off on the face of arm *a* (see view *B*) and the back of *b*; these lines should be at an angle of 60 degrees with the side of the stock, and the distance between the lines should be equal to the width of the arm pieces. The marking gage is next set to two-thirds the thickness of the stock and both *a* and *b* are gaged from the face side on the edges for cutting away the stock between the 60-degree lines on the face of *a* and the back of *b*; arms *a* and *b* can then be put together and the lines for *c* laid out. The check for arm *c* is one-third the thickness of the stock, gaged from the face of the assembled pieces. When arm *c* is cut, it may be put into place, and the lines to fit the angles where *a* and *b* join can be marked on the back of *c*, which is then gaged from the face side with the last gage setting, which equals one-third of the thickness. The face sides in the illustration are designated by *f*.

To fit and join spiders having an odd number of arms, it is most convenient to lay out the arm centers and miters on a stiff and true lay-out board; the board should be true, because the spider is to be assembled on it finally. The center lines should be drawn on the board well beyond the arm ends, so that the arms, which have a center line on one face and on the outer ends, may be set to them (see view *C*, Fig. 5). As soon as the arms are jointed, they should be fastened to the board by toe-nailing through the sides and ends, and the central miters should be drawn together with pinch-dogs. Each joint should be numbered and a mark placed on the end of one arm and the board, so that they may be returned to their proper positions when being glued. The best way to secure the central miters is with a feather or spline in each joint, although this is often dispensed with, the butt joints being glued and the spider being glued and screwed to the drag hub. When the arms have all been fitted, they should be laid out and band-sawed so as to leave as little hand finishing as possible.

Tapering Spider Arms

Spider arms usually taper from the hub to the fillet where they join the rim. This taper must be laid out on each edge of the arm if it is to be worked by hand, but if it is to be tapered on the jointer the laying out may be dispensed with. Where there is a bead on the inside of the rim, the taper extends to the end, but if the wheel or pulley has no inside bead, the taper stops short of the end to provide stock for a fillet. This necessitates rechucking the job to turn the fillet on the under side; consequently it is probably more economical, in most cases, to extend the taper to the end of the arm and then apply leather fillets where the arm joins the rim of the pattern. The tapering part is sometimes formed on small spiders by turning, but this is dangerous work and is not to be recommended. The safety-first rule should always be followed even though the work may require a longer time.

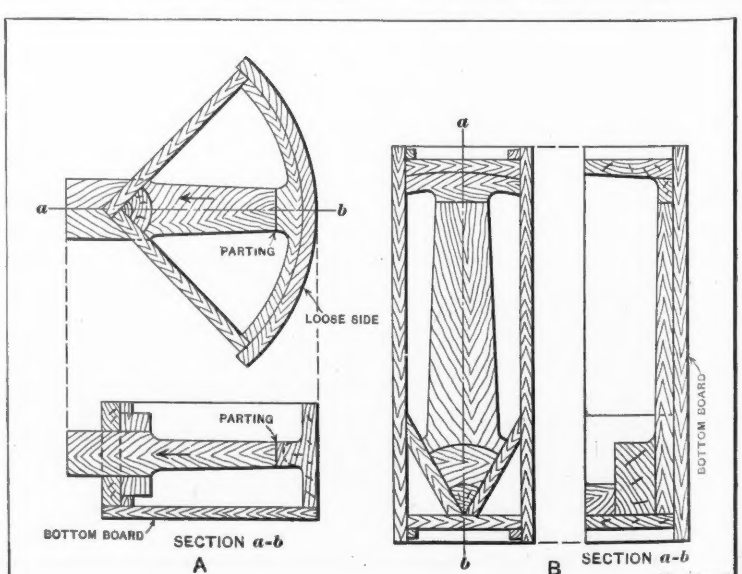


Fig. 4. Core-boxes used for forming Wheel Molds

Working Spider Arms to Form

In almost every case it will be found more economical to work the arms to form before fastening them to the rim, and unless the spider is very small, the arms should be formed before the spider itself is assembled. The arms of pulleys and flywheels are generally elliptical in cross-section, which is usually shown at the hub and rim ends on the drawing with the dimensions giving the widths and thicknesses. If the section is elliptical and the proportion of width to thickness is about 2 to 1, an elliptical section for marking out the templet may be secured by turning a cylinder equal in diameter to the thickness of the arm, and cutting and planing it at an angle until the angled section at the center equals the arm width.

The arm section may be laid out as shown at *D*, Fig. 5, by first drawing a square section of the arm, and from the center scribing a circle equal to the width of the arm. The curvature of the sides is made equal to radius *r*. A section of the arm at each end should be laid out full size, and lines tangent to the section curve drawn at the corners of the square section. These lines are next transferred to the arms at the points corresponding to the sections and are connected by straight lines; the arms are then chamfered as at *A*, Fig. 6. Templets are used while working the section at each end to form, and the space between these sections is worked in a straight line with a spoke-shave and small plane. A straightedge that will just reach between the templet positions may be used for testing this part of the work. This same plan is followed in the working of levers and other patterns that have cross-sections of a similar shape.

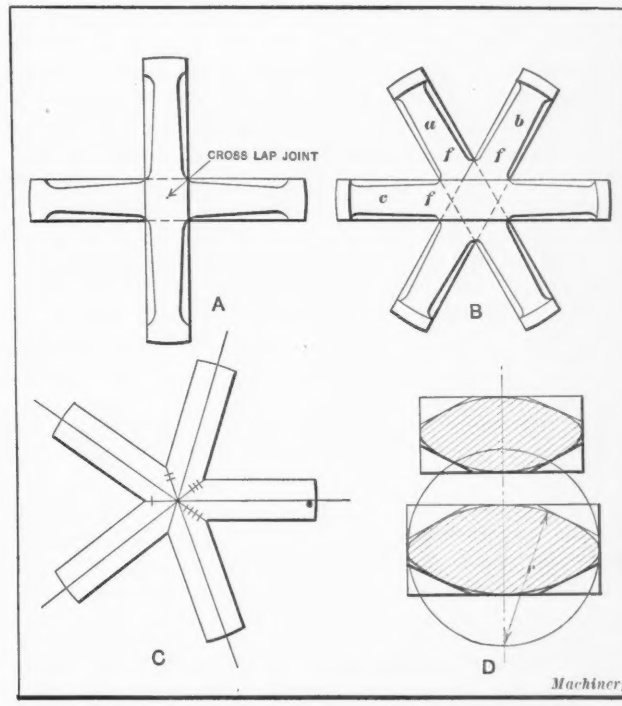


Fig. 5. Construction of Patterns having Arms or Spokes

Where the fillet on the end joins into the bead, it should be left full and finished after the spider is in place. When the arms are finished, they are reassembled with glue and fastened to the board until dry. If the arms have been tapered to the ends, pieces corresponding to the taper will have to be fastened under the ends to bring them level. A hand-screw should be used on the end of each arm to draw it down, and it is a good plan to screw the other end to the board.

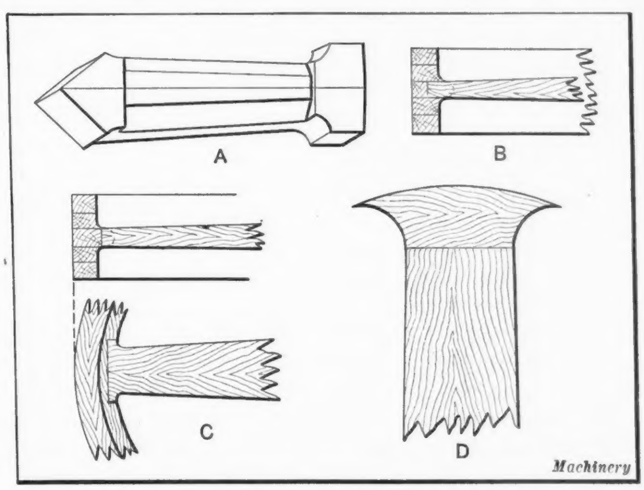


Fig. 6. (A) Arm and Spoke roughly formed. (B, C, and D) Methods of attaching Arms or Spokes to Rims

Fastening Spiders to Rims

The best way to fasten a spider in place is to check it in when building the rim as shown at *B*, Fig. 6, but this construction costs a little more than to notch the rim as at *C*. In the latter case, the spider arms are fastened by screws and sometimes with dowels from the outside of the rim. If there is no bead, or if the rim is too thin for checking, the spider will have to be fastened through the rim, and the fillets formed by fastening hard wood pieces at the end of the arm as at *D*, with the grain running at right angles to the grain in the arm. Spiders for double-armed pulleys are made in this way and are held in place with loose skewers fitting holes bored through the rim into the end of each arm. The rims of bevel gears, owing to their shape, often afford but little chance to fasten the spider which can only be notched in a short distance, and they must not be fitted or clamped too tightly, as it is an easy matter to spring the rim. Standard pulley patterns are usually made with a metal spider and rim, and the spider is not fastened to the rim, as it is possible to make several widths of rim from the same pattern when the spider is loose.

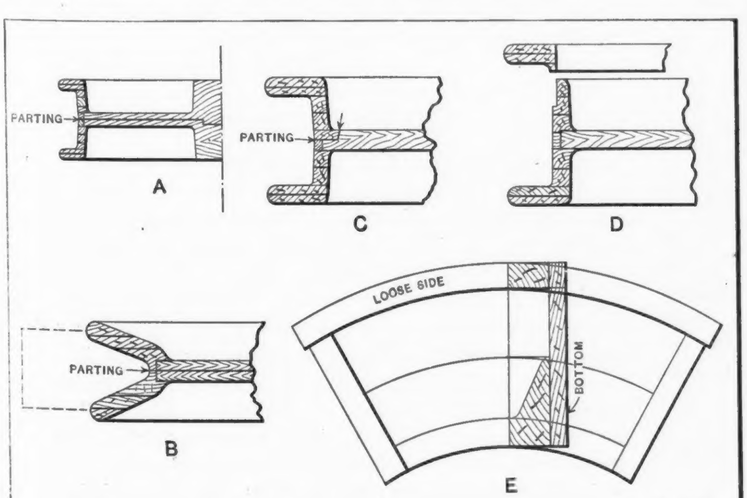


Fig. 7. Pattern Work on Flanged Wheels

Wheels Made without the Use of a Pattern

Many wheels of different kinds are made without a whole pattern, and in some cases with no pattern at all, the arms being formed by cores and the rim by a sweep. This is the cheapest method of making a wheel from the pattern shop standpoint, but it results in an increased cost for molding. Small wheels may be made by making a plain cylindrical pattern corresponding to the outside diameter and face width of the wheel to be made. If the hubs are to come flush with the edges of the rim, a cope and drag print is placed on the pattern, but if the hubs are short, the core-prints may be placed in the arm box. It sometimes happens that the hubs project beyond the rim, in which case bosses will have to be placed on the cope and drag sides to make up for the part not formed by the core. A print is sometimes provided on the drag to locate the arm cores, but they may be set by measurement.

Another way of forming the rim, and the one most commonly used, is by means of a segment or part pattern that is moved in a circle as each section of the mold is rammed, its movements being guided by a bar connecting it with a central pin driven into the sand bed. For a small wheel, an entire arm is made in a core-box as illustrated at *A*, Fig. 4. This core-box must embrace a sector of the circle corresponding to the number of arms in the wheel; if there are to be three or four arms, the sector must include a third or a fourth of the circle, as the case may be. The arm is parted at the rim fillet and draws through the side of the box at the hub center in the direction indicated by the arrow. The side of the box that forms the inside of the rim is loose to draw the opposite way. These cores are usually fastened together before being set into the mold.

The arm boxes for larger wheels are made with a half arm as at *B*, fastened to the bottom board. This box, which is rectangular in form, must be wide enough to allow about two inches each side of the arm or to embrace a sector of the hub corresponding to the number of arms. The depth of the box equals half the depth of the deepest part of the wheel, and as the sides may be given a generous amount of draft, there is no necessity for partings at the corners. By cutting the arm across at the fillets at each end and screwing it to the bottom board so that it may be removed readily, the same box may be used for several sizes by making new arms and ends at the rim. Such a wheel would have the same size hubs and the same arm sections as the one for which the box was made. In making the wheel, the molder sets the cores on a circular iron plate (two half cores being fastened together to form each arm) to center lines which regulate the spacing of the arms. The space between the arm cores is filled in with green sand to form the inside of the rim between the cores. A segment of rim reaching from core to core is used to hold the sand in place. This space is sometimes finished by a sweep, turning on a central spindle, in which case it is usual to sweep the outside in the same way, and sometimes the outside is made in loam with the brickwork built on an iron ring. The plate, with the arm cores, is lifted away while the outside is being made, and instead of a sweep, segment, or part pattern, a number of segment cores are sometimes used for this purpose; but this method does not give the best results, as the rim will be uneven and not true unless the cores are made and set exactly right.

* * *

AUTOMOBILES IN AMERICA AND ABROAD

There is a motor vehicle registered in the United States for every twenty-four persons; in Canada the proportion is probably one to each fifty; in England one to two hundred; in Denmark one to three hundred and in France, Belgium, Holland, Switzerland, and Germany about one to every four hundred. In 1917 it was estimated that Italy had one car to each 1000 of the population; Portugal to each 1690; Spain to each 1900; Austria-Hungary to each 2650; and Russia to each 5000. In Australia there was one car for each 140 of the population, and in South America as a whole, one for each 1430. Many a minor city in the United States has more cars than the whole of China or Japan. France for many years headed the list of automobile exporting nations, followed by Great Britain, the United States, Italy, Germany, and Belgium. In the United States the domestic requirements were so great that the majority of the cars were absorbed at home. European motor builders have doubled, tripled, and multiplied their plant and equipment ten times in four years and yet their combined capacity is still the merest fraction of our own. There is an increasing demand in England for light inexpensive machines. It is stated that one factory intends to manufacture within one year as many cars as the entire British output for 1914. The price of this car is expected to be approximately from $600 to $750.

* * *

The man who says he can't is generally right about it.

METHOD OF DETERMINING ANGLE FOR MILLING RADIAL V-GROOVES

By ADOLPH MOSES

A method of deriving the formula for determining the angle at which to set the index-head when milling radial V-shaped grooves is illustrated in the accompanying diagram. It is required to find the angle of elevation x, when the number of grooves to be cut and the included angle of the cutter are known. Referring to the diagram,

$$\text{Angle } x = \text{angle } HJK$$

$$\cos x = \frac{JK}{HJ} = \frac{JK}{r} = \frac{EG}{r}$$

But

$$EG = \cot\frac{V}{2} \times EF$$

and

$$EF = BC = r\left(\tan\frac{360\text{ deg.}}{2n}\right)$$

Therefore,

$$EG = \cot\frac{V}{2} \times r\left(\tan\frac{360\text{ deg.}}{2n}\right)$$

and

$$\cos x = \frac{\cot\frac{V}{2} \times r\left(\tan\frac{360\text{ deg.}}{2n}\right)}{r} = \cot\frac{V}{2}\left(\tan\frac{180\text{ deg.}}{n}\right)$$

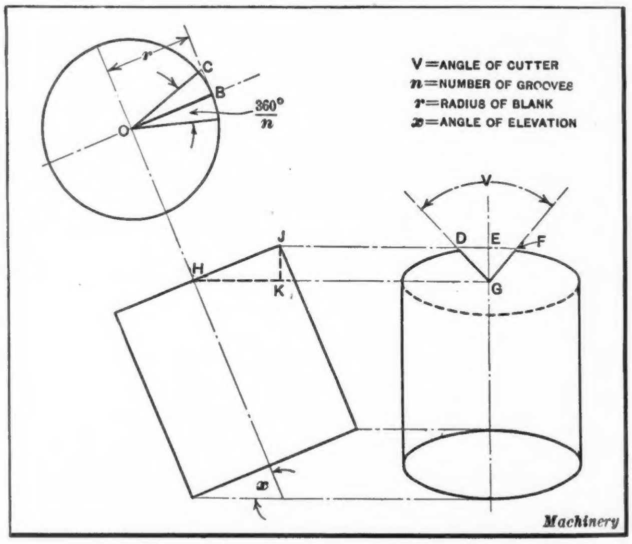


Diagram showing Derivation of Formula for finding Angle of Elevation

The foregoing formula is similar to that found on page 192 of "Planing and Milling" (MACHINERY'S Mechanical Library) for determining the angle for setting the index-head when milling the end teeth in end-mills.

* * *

LARGE WELDING JOB

An interesting welding job was recently accomplished by the Metal & Thermit Corporation, New York City, on the cast-steel stern frame of the U. S. army transport, *Northern Pacific*. The weld is said to be the largest marine weld ever made. The section welded was entirely broken through as a result of the severe strain to which the frame was subjected when the transport ran aground last winter in a dense fog off Fire Island. The stern frame was broken just above the upper rudder lug where the casting was hollow, and measured almost two feet in diameter. The walls of the casting at this point were about 3 inches thick. The weld, which required 1400 pounds of thermit, and which was made without removing the casting from the ship, obviated the delay and expense which would have been entailed by the alternative of purchasing and installing a new casting.

Important Phase of the Employment Question

Methods of Dealing with Employes which Insure the Maximum of Efficiency Coupled with Friendly Relations between Employer and Employe

By J. J. HARTLEY, Factory Manager, Borg & Beck Co., Chicago, Ill.

THE company with which the writer is connected has happened to require the services of additional men during the past two months, and even though the plant is not conveniently situated with respect to the manufacturing center of the city, eligible applicants have numbered fully seventy-five for every opening we have had to offer. Ninety-five per cent of all the men who applied were under forty-five years of age, and probably ninety-eight per cent of the total were eligible for employment, as based on our method of selecting men. We have not tried to hire men at pre-war rates, but on the other hand, have offered and are now paying a liberal guaranteed hourly rate to all our production workers. They are frankly told, when being hired, that they will ultimately be given piece-work, and that the time allowances made will permit the average man to make fifty cents per hour or better. When it is stated that this arrangement applies to intelligent men having limited or no previous experience, we feel we are fair. This, we believe, is recognized by our men, and particularly by those who have thus far been given piece-work. These men have made good from the start, and in most cases average more on a weekly basis than fifty cents per hour.

The writer, having personally interviewed the majority of these applicants, obtained from some of them information which strongly indicated that some employment agents have been endeavoring to hire good intelligent workers at a much lower hourly rate than the increased high cost of living justifies. It would seem that the safest and fairest policy for the employer to pursue is to consider carefully, and to fix a definite schedule of wages and salaries that will be fair to the employe, for a fair deal is always quickly recognized by the majority of workers in manufacturing industries.

The Personal Equation in the Hiring of Help

It always requires a man with knowledge, gained by years of experience in supervision, to hire men, and probably there never was a more opportune time than this—during the reconstruction period—for the superintendent or factory manager to assume the duties of employment agent. The man with the important responsibilities of hiring help, to be successful, should receive an applicant in a cheerful and sympathetic manner. The man who offers his skill and labor directly is entitled to the same courtesy and consideration as the salesman, who offers labor for sale indirectly in the form of a finished product.

It is not good business, nor fair, to greet a man with the notice "No help wanted" when he comes at loss of time and money to offer his services. We owe him the courtesy of an interview, and if we cannot employ him, we might at least offer him an explanation as to why we cannot. The hiring of and dealing with employes is of first importance. A few manufacturing concerns have fortunately recognized this fact, and they first locate the men of apparently the right qualifications, hire them, and then see to it that they are not easily discharged, unless conditions justify such dismissal. It is safe to say that the employment department records in such establishments will always reflect credit and profit, resulting from minimum help turnover, which almost invariably prevails in establishments of this kind.

The Piece-work System and the Average Man

The next thing of importance after hiring men is to provide them with a means of earning maximum compensation through their own individual effort, which can best be accomplished by paying them a given price per unit, rather than for the hours and minutes worked within the daily schedule. Superintendents and foremen, experienced in placing their employes under the price-per-piece system, commonly called "piece-work," will doubtless agree that a large majority of workmen will increase their own production at least 30 per cent and also the quality of their output, under the piece-rate system. When once started and accustomed to piece-work, these men, if treated fairly through proper time-study methods and price allowance, will invariably become strong advocates of the piece-work system, and rarely ever thereafter will they be satisfied to work under the straight hourly rate, because under the piece-rate system they are usually able to earn from 30 to 40 per cent more.

Probably the main factor in retarding a more general adoption of the piece-work system has been the lack of thorough methods of making time studies, and the failure to take into account all conditions which arise during the course of a reasonably long period of work. On the basis of fairness time allowances and piece prices should be set, under which a workman can average earnings over the entire period of his employment on one or more jobs, equal to or better than the stated rate. Before setting the price, it is desirable to tell a man the minimum average wages it is reasonably sure he can earn by fair effort, and to assure him at the same time that the price will stand without revision downward as long as the conditions prevail under which the time studies and price allowances were determined. He should further be assured that, if by extraordinary effort he can double his earnings, no obstacle will be placed in his way.

As competitive employers, we must base our production costs on average man quality. If the total man force is divided into five classes, which will ultimately be determined under a cost-per-unit system, the middle or average man will be found whose qualifications are equal to the price we are willing to pay and the stipulated minimum earnings we are willing he should make. It is interesting to note, from production records, that the earnings of the men in the two lower classes will usually offset the greater earnings of the men in the two higher classes, thus effecting an average earning for the whole, equal to that of the average man.

Fairness in Setting Piece-work Rates

In making time-studies and setting piece prices, the man who is going to produce regularly should always perform the operations under the time-study man, no matter whether he be a man of the first or the fifth class, and he should be properly and thoroughly trained before he is given piece-work. It used to be the practice to employ specialists or expert men as demonstrators. This practice may still prevail in some plants, but it has been found unsatisfactory and misleading by numerous concerns that are today making time studies with the regular operator, and thus obtaining most satisfactory results.

* * *

It is not essential that any kind of packing for steam engines be screwed up tight. When the rod is in good condition, the packing can be made sufficiently tight by screwing up the gland nuts with the fingers while the packing is cold; and when steam is applied to the cylinder and around the rod, the packing will become steam-tight.

PUNCH AND DIE FOR CUTTING AND PUNCHING T-IRON

By ERNEST A. WALTERS

The sequence of punch press operations performed on T-iron bars in the process of making beams for reinforcing purposes, is indicated at *A*, *B*, and *C* in Fig. 1. The dies

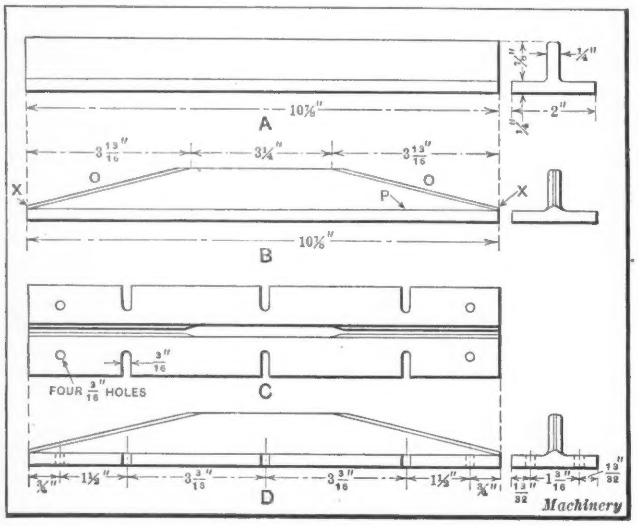


Fig. 1. T-iron Bar after Each Successive Operation

used in these operations are of unusual design, and although the cutting-off dies employed in the first two operations do not produce a perfectly clean cut, sufficient accuracy is obtained to meet the requirements, and the work is accomplished rapidly and economically.

The first operation consists of cutting the bars to the length indicated at *A*. The punch and die employed for this purpose is shown in Fig. 2. The hardened and ground tool steel shearing punch *C* is secured in holder *D* by means of the fillister-head screws *E*. The die *F* is made of hardened and ground tool steel, and is fastened in a slot cut across the bolster plate *G* by fillister-head screws *H*. The heel block *I* is also hardened and ground and seated in a slot in the bolster plate *G*, being held in position by the fillister-head screws *J*. The punch and die when in operation cuts at two points *M* and *N*. The stress on the punch, which results from this action, has a tendency to move the punch sidewise, but this tendency is resisted by the heel block *I*, and the proper alignment is thus maintained. A piece of T-iron

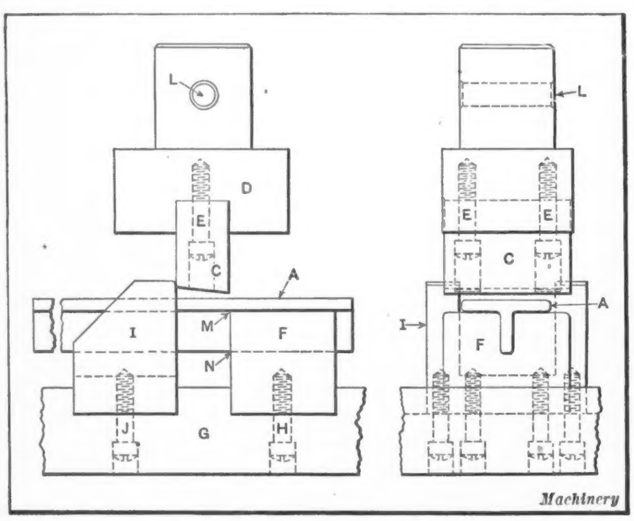


Fig. 2. Cutting-off Punch and Die

is shown at *A* in position to be cut off. The bolster plate *G* is made of cast iron and is fastened with bolts to the punch press bed. The punch-holder is pinned to the ram of the press at *L* in order to prevent the punch from turning while in operation.

Knife-edge Dies Employed for Angular Cut

At *B*, Fig. 1, the T-iron is shown after the second operation has been performed, which consists of cutting off an angular shaped piece at each end. It is obvious that these cuts, which are indicated at *O*, cannot be made in an ordinary shearing or cutting-off die on account of the lack of space near *X* caused by the angle formed by the edges *O* and the surface *P*. The special chisel-edged punch and die shown in Fig. 3 was therefore designed and built to cut the ends as indicated. The chisel edges of the punch and die are set to allow a clearance of 3/32 inch between them when the punch is at the end of its downward stroke. The edges of the punch and die sink into the metal but a short distance before the piece snaps off. The sharp burrs which remain on the edge of the broken section are then removed by filing. As will be seen by referring to Fig. 3, the punch and die are aligned by means of guide pins *A*. These pins are made of hardened and ground tool steel and are pressed into the cast-iron bolster plate *B*. The pins *A* are a close sliding fit in the holes bored in the punch-shoe *C*.

The chisel-edged punch *L* and die *M* are identical in shape, and after being hardened and ground, are drawn to a light

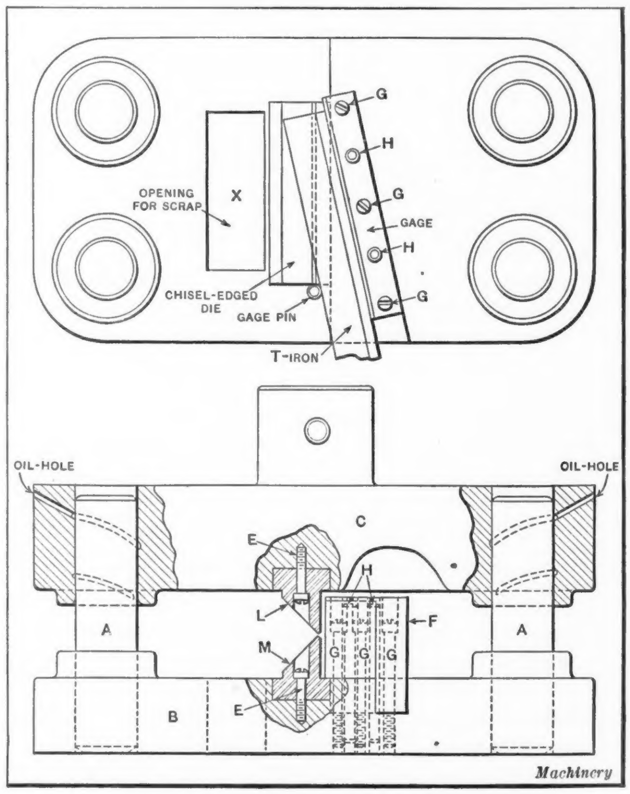


Fig. 3. Chisel-edged Punch and Die for cutting off Ends of T-iron Web

straw color. Screws *E* hold the punch and die in slots which are cut across their respective shoes as shown in section. The gage or guide *F* is made of hardened tool steel, and is seated in a slot cut diagonally across the bolster plate *B*, being held in position by means of dowel-pins *H* and fillister-head screws *G*. In the plan view, the bolster plate and chisel-edged die are shown with the T-iron in place previous to being cut off. The opening *X* allows the scrap to drop through and into a receptacle underneath the press.

Dies for Punching Slots and Holes

At *C* and *D*, Fig. 1, the T-iron is shown as it appears after the third operation. The perforating and slotting punch and die employed for this operation is shown in Fig. 4. The T-iron *A* is shown in the proper position for punching. It will be seen by referring to the illustration that the die-shoe *C* is slotted to allow the T-iron to slide freely within it, and at the same time the slot acts as a guide. The stop *J* is attached to the shoe at the end of the T-slot as shown. This construction makes it possible to use very short punches,

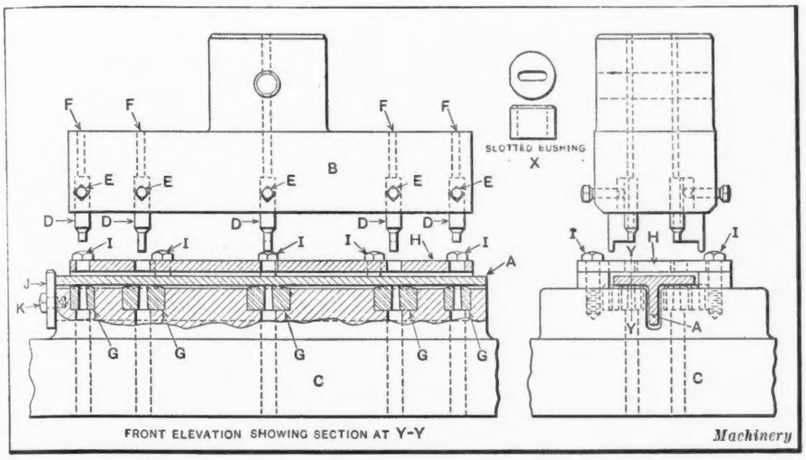


Fig. 4. Punch and Die employed for slotting and perforating T-iron

which are necessary in this case, as the thickness of the metal exceeds the diameter of the punch. Set-screws *E* hold the punches in place, and they may be readily removed from the punch-holder *B* by means of the holes *F*.

The punch-holder *B* and die-shoe *C* are made of cast iron. The punches are, of course, made from hardened and ground tool steel, and are drawn to a color between a purple and a blue. The bushings or dies *G* are made of hardened and ground tool steel and are pressed into the counterbored holes of the die-shoe *C*. One of these slotted bushings is shown in detail at *X*. The stripper plate *H* is made of machine steel and is held in place on the shoe *C* by means of cap-screws *I*.

* * *

BRITISH GOVERNMENT PLAN FOR INDUSTRIAL RESEARCH

The British Government has placed a fund of $5,000,000 at the disposal of the Research Department to enable it to encourage the industries to undertake research. The details of the scheme were published in a recent number of *Engineering*. The Advisory Council for Scientific and Industrial Research has recommended, after consultation with manufacturers and others, that the new fund should be expended on a cooperative basis in the form of liberal contributions by the department matching the sums raised by voluntary associations of manufacturers established for the purpose of research. By this method, the systematic development of research and the cooperation of science with industry will be carried out under the direct control of the industries themselves.

It is hoped that the cooperation of the firms concerned in any one industry may enable research work to be undertaken that could not have been dealt with by individual firms. If the firms in an industry which are engaged in the production of similar articles, or if firms in different industries which make use of the same raw or semi-manufactured materials, will combine to improve those articles or materials, to discover new processes, or to increase the efficiency of existing processes, the department will contribute liberally to a joint fund for this purpose. The fund for each industry will be expended by a committee or board appointed by the contributing firms in that industry, and the results obtained will be available for the benefit of the contributing firms. It is anticipated that each firm subscribing to research organization will have the following privileges:

1. It will have the right to ask technical questions and to have them answered as fully as possible within the scope of the research organization and its allied associations.

2. It will have the right to recommend specific subjects for research, and if the committee or board of the research organization of that industry considers the recommendation of sufficient general interest and importance, the research will be carried out without further cost to the firm making the recommendation, and the results will be available to all the firms in the organization.

3. It will have the right to the use of any patents or secret processes resulting from all researches undertaken, either without payment for licenses or for a nominal payment.

4. It will have the right to ask for a specific piece of research to be undertaken for its sole benefit at cost price, and if the governing committee or board approves, the research will be undertaken.

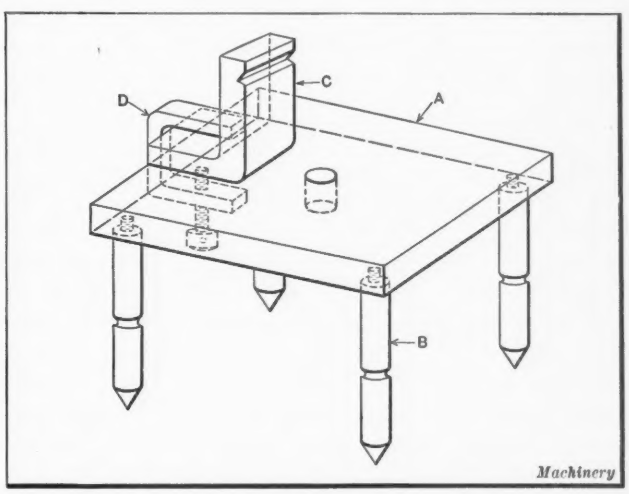
No firm outside of the organization will have any of these rights. Several of the associations have established bureaus of information which give to each of their members technical information relating to the industry, and translate copies of foreign publications that relate to their particular industry. The results of researches conducted by any research association, will belong to the association itself, which will hold them in trust for the benefit of its members. The Government will have the right of veto in case it is proposed to communicate the results of research to a foreign corporation or individual, and the right, after consultation with an association, of communicating the results of its discoveries to other industries if it seems advisable to do so.

* * *

SURFACE TABLE FOR LAYING OUT SMALL WORK

By AUGUST J. LEJEUNE

The accompanying illustration shows a surface table that has been very useful in laying out small work, especially when making tools and gages. This table is not likely to be subjected to the rough treatment generally given the ordinary surface plate and can, therefore, be relied upon for greater accuracy. The top *A* is made of steel about 1/2 inch thick and 6 inches square, which is hardened, ground, and lapped to a true surface. Great care should be taken in finishing the surface and edges of the top so that the surface of the work may be tested by comparison and tested for accuracy with the squaring instruments. The legs *B* have 5/16-inch threaded ends that are screwed into the top, and are pointed at the opposite ends so that the table can be set firmly on the bench. A 5/8-inch hole is drilled through the center of the table top, into which any projection may be inserted, thus allowing the piece to lie perfectly flat while laying out the work upon the opposite side. A small angle-iron *C*, is finished all over and attached to the table by means of clamp *D*. This facilitates the laying out of work which cannot be handled on a flat surface, another clamp being used to hold the work against the side of the angle-iron. A V-slot, which has an included angle of 90 degrees, and which is about 5/16 inch wide on the face of the angle-iron, is milled in the angle-iron to permit the holding of cylindrical stock.



Surface Table for laying out Small Work

CONTRACTS OF SALE

By CHESLA C. SHERLOCK

The interesting point in contracts of sale, from a legal standpoint, is generally confined to a consideration of the effect of warranties which are made concerning the quality and durability of the article sold. This applies with special force to contracts of sale involving machinery.

Warranties in Contracts of Sale Pertaining to Machinery

The manufacturer generally has printed forms which he uses in his business dealings with customers and, as the courts have pointed out, the choice of language used is his own. Usually the warranties are contained in these printed forms which also expressly set forth the liabilities of both parties with respect to the purchase. These contracts are usually drawn up along the following lines: There is a general warranty that the machine will perform the work for which it is intended, that it is made of good material, is durable if used with reasonable care, and will do the work for which it is intended as well as any other machine.

Generally, the remainder of the contract deals with what might be termed a special warranty which states that, if the machine should fail to work well, the purchaser shall give notice and the seller shall make it do good work, and that, if the seller should fail to do this, then the purchaser may return the machine and receive all cash or notes given in payment therefor. There is usually a further clause which sets forth that a certain specified use of the machine shall be deemed an acceptance of it upon the part of the purchaser, and as a compliance with the warranty on the part of the manufacturer or seller.

How Language of the Warranty Affects Liability of Manufacturer and Purchaser

The language used in contracts of sale becomes of vital importance when legal action is taken by either party to recover damages or to substantiate a claim. The question then arises: What have the parties meant by the language used? The fact that the manufacturer has composed the written form of the contract in most instances is a trivial one, but at the same time it is a point that the courts do not fail to take into consideration. It can be said with reasonable certainty that, in the construction of such a contract, the fact that the manufacturer has produced the form and used his own language may react against him. If there is any uncertainty or a double meaning in the contract as worded, it is invariably construed against the manufacturer, because it was his own language which caused the uncertainty.

The courts take a view that is not altogether in keeping with the rules applying to the construction of contracts generally. They hold that such contracts of sale as mentioned above limit the warranty, and furnish the purchaser his only remedy in case of breach thereof. It is elementary in the law of contracts that the court will construe the language of the contract according to the intention of the parties, and this intention is gathered from the language used in the agreement as a whole, and from such surrounding facts and circumstances as are relevant to it; but when one party has had the choice of language used in the agreement, he is likely to lose in case there is an instance of doubtful construction. The courts do not always adopt the view of intent, however, but often hold that the contract of sale limits the warranty, and they point to it as the only remedy that the purchaser has, even though it might have been the intention of the parties that he should have other remedies not enumerated in the printed form of the contract.

Cases Illustrating Decisions of the Court

In two North Carolina cases it was specifically held that, if a contract of sale has conditions attached to it concerning warranty, such conditions are fatal to recovery for a breach, or to the right to assert damages for it, if the purchaser has failed to comply with the conditions. In a Kentucky case, it was held that if the vendee of property had agreed in the contract of sale to return the property in case there was a breach of warranty, the return of the article was the only condition upon which he could demand fulfillment of the warranty.

In a Minnesota case, where the warranty of a machine was absolute and unconditional, it was held that the purchaser's right to rely upon it was not affected by an agreement to notify the seller so that the latter might have an opportunity to remedy the defect, nor did the purchaser's right depend upon any offer to return the machine for breach of warranty. A purchaser has a right of action for his damages, or, when he is sued upon notes given for the purchase price, he may counterclaim the amount of his damage. The last case mentioned is one that made its decision along lines which, it seems, would be in conformity to the rules of law governing the construction of contracts generally.

In a Georgia case, the warranty stated that a certain machine sold was "well made, of good material, and durable, when used with proper care. If upon one day's trial the machine should not work well, the purchaser shall give immediate notice... and allow sufficient time to send a person to put it in order. If it cannot then be made to work, the purchaser shall return it at once... and all cash and notes received in settlement will be refunded. Continuous use of the machine, or failure to notify or return the machine as agreed, shall be deemed an acceptance of the machine by the purchaser. No agreement or order other than that printed in this order is binding." It was held in construing this warranty as attached to a contract of sale, that it limits the remedy of the purchaser to that prescribed in the contract; and where the purchaser fails to give notice or to return the machine, he cannot allege the breach of warranty as a defense to an action for the purchase price.

In speaking of a case arising in Illinois, the court, in determining another case, said: "It is well settled that where one seeks to enforce a warranty imposing mutual and dependent obligations and covenants, he who seeks to enforce it must show compliance on his part before he can insist upon performance by his adversary. The clause in the warranty relative to notice and return are material and substantial parts of it, and for the protection of the seller, and the purchaser is no more at liberty to disregard them than he is any other clause in the contract. When appellant made this contract he agreed that he would satisfy himself within one day whether the machine worked to his satisfaction and filled the warranty, and further that if he did not, he would at once give the notice required by the contract, and that if he failed to give such notice, such failure should operate as an acceptance of the machinery and as a fulfillment of the warranty."

Duty of Manufacturers and Sellers of Machinery under Warranty Clauses

Under the law of contracts of sale, there is one point that indicates a very plain duty to manufacturers and sellers of machinery under warranty clauses in these contracts. It is that the courts generally construe such conditions as are made precedent to the remedy for a breach of the warranty, in favor of the manufacturer, provided there is no uncertainty about the language used or the agreement of the parties. If the purchaser has failed to perform his portion of the contract, as refers to notice or the return of the machinery, the manufacturer is of course relieved because his own liability depends upon these conditions, which must be fulfilled on the part of the purchaser before the liability of the seller of the machinery comes into being.

The effect of these contracts must be apparent to all. There may be an actual breach of the warranty and it may have existed all the time, yet the manufacturer, under the ruling of the courts, cannot be held for it, unless the purchaser has conducted himself in the manner set out in the warranty itself. There is, however, the duty of caution and care resting upon the manufacturer or seller, both as to the agreement and as to the language used. The language must be clear, concise and definite enough to be perfectly plain.

Fig. 1. Apparatus used for welding Gas Tanks—Note the Work-holding Stands and Overhead Connection with Blowpipes

Tank Welding by the Oxy-Acetylene Process

By CHARLES C. PHELPS

THE oxy-acetylene process of welding has been used so extensively and effectively for repair work of various kinds that such apparatus is sometimes considered to belong exclusively to this field. However, the fact is that the application of the oxy-acetylene method of welding has given such good results on many classes of work done on a manufacturing basis that the autogenous process is now being utilized, and on an increasing scale, for making many different products. Contracts recently completed for the Government by the Ireland & Matthews Mfg. Co., of Detroit, Mich., are good examples illustrating the application of the oxy-acetylene method of welding to duplicate work required in large quantities. The first contract was for 25,000 naval floats which were made of pressed steel parts welded together by the oxy-acetylene process. Upon completion of this large order and after severe tests, the Government accepted all the tanks with the exception of thirty-four, which were rejected owing to defective welds. This remarkable record was surpassed by the work done on the next contract undertaken for the Government, which involved the production of 25,000 toxic gas tanks, a number of which are shown, ready for shipment, in Fig. 2. These tanks underwent a more drastic test, with only six rejections.

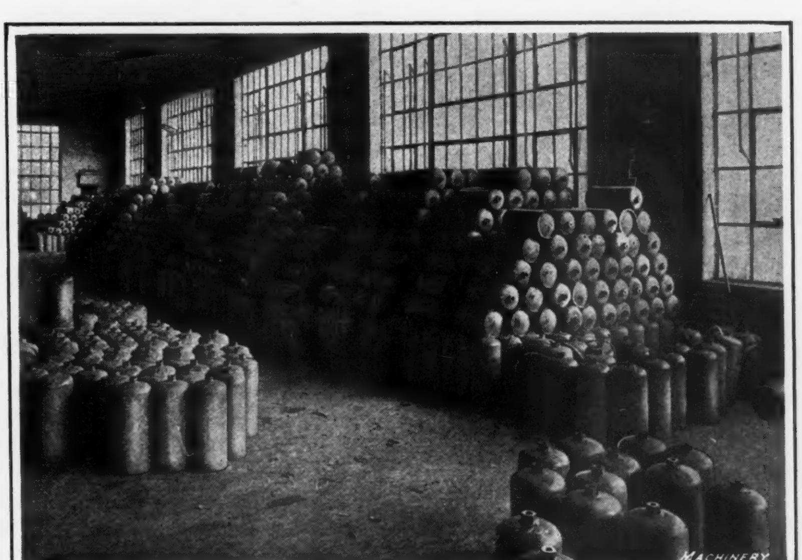


Fig. 2. A Few of the 25,000 Gas Tanks which were welded by the Oxy-acetylene Process

When the first contract was taken, on May 8, 1918, the Ireland & Matthews Mfg. Co. had no welding equipment whatsoever. They installed an Oxweld low-pressure duplex-type acetylene generator, having a carbide capacity of 200 pounds per charge, and started production about three weeks later. The acetylene was conveyed through pipes to the blowpipes and the oxygen was supplied from Linde cylinders connected to the pipe line by a special manifold. About one hundred welding stations were installed. The welding proceeded so rapidly that it was soon found that the generator could not meet the demand for acetylene, and another one of 500 pounds carbide capacity was installed.

Construction of the Gas Tanks

The toxic gas tanks are 8 inches in diameter and 18 inches in height. The top and body of each tank was made from a blank of hot-rolled steel 26 inches in diameter and 0.084 inch thick, drawn in four operations. The bottom was made from a blank of hot-rolled steel 10¼ inches in diameter and 0.140 inch thick, drawn in three operations. The bottom piece was pressed into position and its flange welded to the bottom edge of the tank shell by means of a blowpipe fitted with a No. 5 welding head. A nipple or spout was welded in

the top of the tank. This was made from a piece of 2⅛-inch round bar steel milled to hexagonal shape on one end and drilled and threaded to receive a screw cap. The hole in the top of the tank was first beveled and the nipple was then pressed into this opening, leaving an annular V-groove that was filled with metal from a steel welding rod, a blowpipe fitted with a No. 6 welding head being used for the purpose. Each tank was fitted with straps to assist in carrying it. These straps were made of band iron, ¾ and ⅞ inch wide.

Speed of Welding

The average accomplishment of each operator was fifty-five tanks welded per day of 9½ hours. The length of the bottom weld was approximately 25 inches and of the nipple weld 6½ inches, making a total length of welding per tank of about 31½ inches. Therefore, the daily accomplishment was 55 times this figure, that is, about 1732 inches or over 144 feet, and the average hourly accomplishment was over 15 linear feet of weld. This is remarkably rapid work considering the fact that the girls who did the welding had not had training in this work prior to the war emergency. Furthermore, the speed of operation was not accomplished at the expense of quality. This is attested to by the fact that, after subjecting each tank first to an air pressure of 200 pounds per square inch and then to an additional kerosene oil test which involved a hydraulic pressure of 400 pounds per square inch, there were only six rejections due to defective welds out of a total lot of 25,000 tanks.

The 25,000 naval floats previously referred to were somewhat similar in construction to the tanks and of the same height, although 2 inches greater in diameter. The naval floats, however, were subjected to a much less rigid test, namely, 150 pounds air pressure.

Arrangement of Apparatus

Many special appliances, devised to facilitate the welding operations, undoubtedly contributed to the excellent performance record at this plant. While welding the bottom of each tank it was supported on rollers (as shown in Fig. 1) which permitted turning the tank easily as the work progressed, so that the blowpipe could be applied from the most favorable direction. While welding in the nipple, the tank was held in a vertical position on a stand arranged to swivel, so that the work could always be swung to exactly the desired position. This stand was adjustable, permitting the work to be held at the height most convenient for each operator. The hose leading to the blowpipes was supported overhead, thus reducing to a minimum the weight borne by the operator's hand. When not in use, the hose and blowpipes were hooked up out of the way of the operators.

In addition to the float and toxic gas tank contracts, this equipment has been used in making various parts of welded tubing for airplane motors, aero bombs, trench mortar shells and gas shells and it is now employed in the regular production of welded steel manifolds for motor cars, axle housings and for salvaging stampings.

The importance of absolute gas-tightness for such vessels as toxic gas tanks is apparent, as a defect might permit the escape of a deadly gas at the most inopportune time with disastrous consequences. Oxy-acetylene welding was relied upon to make joints that were perfectly gas-tight, and these withstood the rigid tests. It is of interest to note that this same process was applied not only in making most of the toxic gas vessels of all varieties that were produced in this country during the war, but also in constructing the apparatus in which the poison gases were made.

* * *

A director of the Marconi Co. states that experiments on a new type of wireless telephone are so far advanced that it will shortly be possible to speak between London and New York, while the establishment of a regular commercial service by wireless telephone between London and New York early next year is expected.

AMERICAN ENGINEERING STANDARDS ASSOCIATION

The American Engineering Standards Association, 29 W. 39th St., New York City, has been formed by the American Institute of Electrical Engineers, the American Institute of Mining and Metallurgical Engineers, the American Society of Civil Engineers, the American Society of Mechanical Engineers, and the American Society for Testing Materials, in cooperation with the War, Navy, and Commerce Departments at Washington. The objects of the association are as follows:

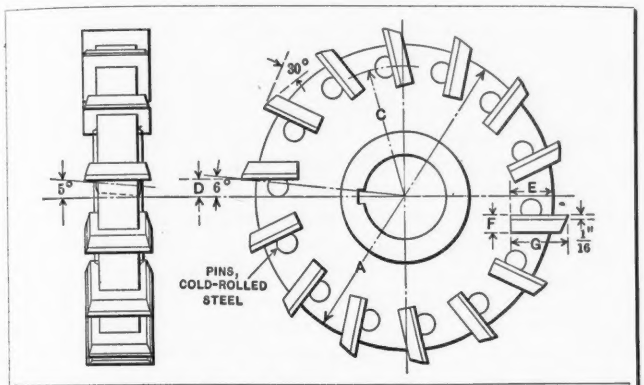
1. To unify and simplify the methods of arriving at engineering standards, to secure cooperation between various organizations, and to prevent duplication of standardization work.
2. To promulgate rules for the development and adoption of standards.
3. To receive and pass upon recommendations for standards submitted, but not to initiate, define, or develop the details of any particular standard.
4. To act as a means of intercommunication between organizations and individuals interested in the problems of standardization.
5. To give an international status to approved American engineering standards.
6. To cooperate with similar organizations in other countries and to promote international standardization.

Several important organizations interested in standardization will be invited to appoint representatives. Any organization may request the association to approve standards which it has formulated, or to approve committees that it has appointed, and by so doing becomes a Sponsor Society. Such a request is entirely at the option of the organization that has formulated or expects to formulate the standard. At the request of the Sponsor, approval of the standards is given when they are the substantially unanimous conclusions of a committee made up as follows:

1. Sectional committees dealing with standards of a commercial character (specifications, shop practices, etc.) shall be made up of representatives of producers, consumers, and general interests, no one of these interests to form a majority. A producer is a person, or the representative of a firm or corporation, directly concerned in the production of the commodity involved. A consumer is a person, or the representative of a firm or corporation, that uses the commodity involved, but is not directly concerned with its production. General interests include independent engineers, educators, and persons who are neither consumers nor producers, as defined above.
2. Sectional committees dealing with standards of a scientific or of a non-commercial character shall consist of persons who are specially qualified, without regard to their affiliations.

The association acts only to bring together those interested in a common object, and when they have completed their work, will at their request, certify that it has been done in such a manner as to justify the adoption of a certain standard. In addition to this work in assisting in the selection of committees and certifying that their work has been done under proper conditions, the association will act as a bureau of information regarding standardization. It will collect information regarding existing standards and the bodies that have formulated and adopted them. This will enable it to promptly give necessary information to those who select a committee to formulate a new standard or revise an old one. It will also enable it to furnish information desired by the working committees regarding what has been or is being done along similar or related lines. It will establish relations with similar bodies in other countries and can do much to promote the acceptance of international standards. It is possible to secure international acceptance of American standards more easily through such a body than in any other way.

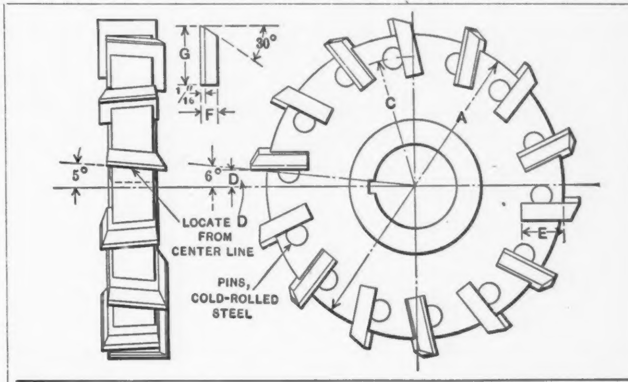
TABLE 1. STRAIGHT-SIDED INSERTED-TOOTH MILLING CUTTERS



Dia. of Cutter, Inches	No. of Teeth	A, Inches	C, Inches	D, Inch	E, Inch	F, Inch	G, Inch	Dia. of Pins, Inch
5	14	4 1/2	1 15/16	0.261	5/8	1/4	7/8	5/16
6	16	5 1/2	2 7/16	0.314	5/8	1/4	7/8	5/16
7	18	6 1/2	2 7/8	0.366	3/4	5/16	1	3/8
8	20	7 1/2	3 3/8	0.418	3/4	5/16	1	3/8
9	22	8 3/8	3 27/32	0.470	3/4	5/16	1	3/8
10	24	9 3/8	4 9/32	0.523	13/16	3/8	1 1/8	7/16
11	26	10 3/8	4 25/32	0.575	13/16	3/8	1 1/8	7/16
12	28	11 3/8	5 9/32	0.627	13/16	3/8	1 1/8	7/16

Machinery

TABLE 2. STAGGER-SIDED INSERTED-TOOTH MILLING CUTTERS



Dia. of Cutter, Inches	No. of Teeth	A, Inches	C, Inches	D, Inch	E, Inch	F, Inch	G, Inch	Dia. of Pins, Inch
5	14	4 1/2	1 15/16	0.261	5/8	1/4	7/8	5/16
6	16	5 1/2	2 7/16	0.314	5/8	1/4	7/8	5/16
7	18	6 1/2	2 7/8	0.366	3/4	5/16	1	3/8
8	20	7 1/2	3 3/8	0.418	3/4	5/16	1	3/8
9	22	8 3/8	3 27/32	0.470	3/4	5/16	1	3/8
10	24	9 3/8	4 9/32	0.523	13/16	3/8	1 1/8	7/16
11	26	10 3/8	4 25/32	0.575	13/16	3/8	1 1/8	7/16
12	28	11 3/8	5 9/32	0.627	13/16	3/8	1 1/8	7/16

Machinery

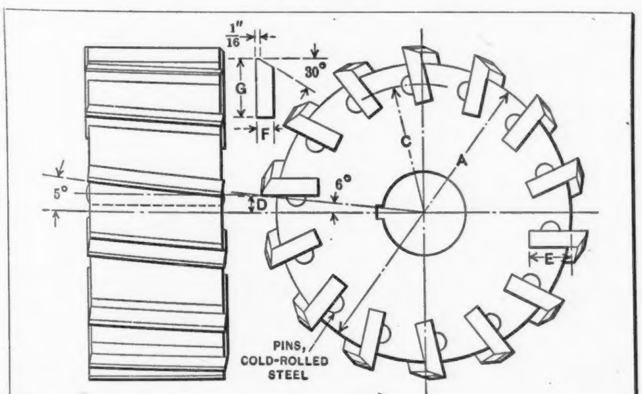
Inserted-tooth Milling Cutters

By WALTER P. LOTZ

INSERTED-TOOTH milling cutters are now in general use in most machine shops. Many shops make their own inserted-tooth cutters; therefore, this article should be of great assistance to machinists and toolmakers who are required to make various types of inserted-tooth cutters. The proportions of the cutters given in the accompanying tables have proved satisfactory upon actual trial and may be used for high-speed milling on heavy-duty milling machines. There may be occasion to differ slightly from the dimensions given in the tables, but this will occur only occasionally. The designs described may be used on almost any kind of work.

The straight-sided inserted-tooth milling cutter shown with Table 1 is one of the most useful types of milling cutters, as it may be employed for straddle-milling, face-milling and also for milling slots. For straddle-milling, when two cutters of this type are employed, the sides of the cutters that face each other after mounting may be used until they are dull; then their position on the arbor may be reversed so that the two outer sides of the cutters (which are still sharp) face each other and thus form a practically new cutter. This feature saves many trips between the grinding machines and the milling machines for sharpening the cutters. Sometimes this feature of double service for the cutters may not be recommended, and in such cases it is advisable to have the cutting edges on only one side of the blades. For

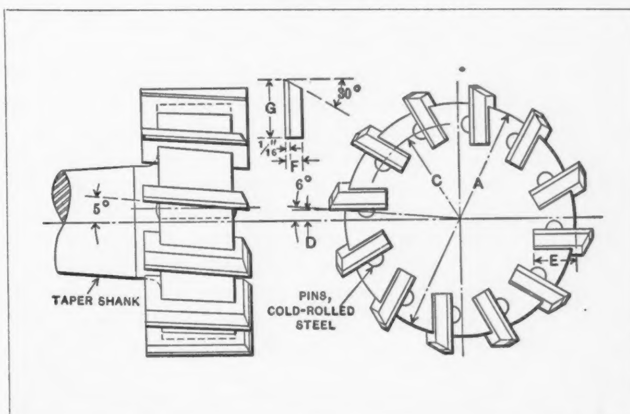
TABLE 3. INSERTED-TOOTH FACE MILLING CUTTERS



Dia. of Cutter, Inches	No. of Teeth	A, Inches	C, Inches	D, Inch	E, Inch	F, Inch	G, Inch	Dia. of Pins, Inch
6	16	5 1/2	2 7/16	0.314	5/8	1/4	7/8	5/16
7	18	6 1/2	2 7/8	0.366	3/4	5/16	1	3/8
8	20	7 1/2	5 3/8	0.418	3/4	5/16	1	3/8
9	22	8 3/8	3 27/32	0.470	3/4	5/16	1	3/8
10	24	9 3/8	4 9/32	0.523	13/16	3/8	1 1/8	7/16
11	26	10 3/8	4 25/32	0.575	13/16	3/8	1 1/8	7/16
12	28	11 3/8	5 9/32	0.627	13/16	3/8	1 1/8	7/16

Machinery

TABLE 4. INSERTED-TOOTH FACE MILLING CUTTERS WITH SHANK



Dia. of Cutter, Inches	No. of Teeth	A, Inches	C, Inch	D, Inch	E, Inch	F, Inch	G, Inch	Dia. of Pins, Inch
2 1/2	8	2 1/8	13/16	0.131	1/2	1/4	3/4	1/4
3	10	2 1/2	1	0.157	1/2	1/4	3/4	1/4
3 1/2	10	3	1 1/4	0.183	1/2	1/4	3/4	1/4
4	12	3 1/2	1 7/16	0.209	1/2	1/4	7/8	1/4
4 1/2	12	4	1 11/16	0.235	1/2	1/4	7/8	1/4
5	14	4 1/2	1 15/16	0.261	5/8	1/4	7/8	5/16

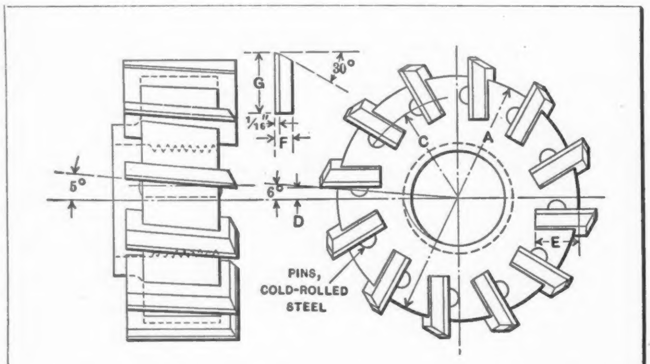
Machinery

milling a slot, a cutter such as shown in the illustration accompanying Table 1 may be used; when the cutter is ground and becomes under-size, every other blade may be moved out on one side and the remaining blades moved out on the opposite side, producing a cutter, half of the blades of which are cutting on one side while the remaining blades are cutting on the opposite side. This alteration will compensate for the under-sizing and will bring the cutter back to its former size.

There are instances when the inner sides and bottom of the work are to be milled, and in such cases it is advisable to use two cutters which are arranged so that the blades interlock with one another. The keyway in the hole of one cutter should accordingly be advanced, bringing the blades out of line with each other and thus allowing them to interlock. It will be noted that the tapered pins are placed at an angle of 5 degrees, while the cutter blades are straight, and also that the angle of the pins is constant for all types of cutters.

The illustration accompanying Table 2 shows a stagger-sided inserted-tooth milling cutter, the design of which is similar to the straight-sided cutter, except that the blades are staggered. A cutter of this type produces a shearing cut with a minimum amount of chatter, and is used mainly for milling slots or grooves in solid masses of metal. This cutter is kept up to size in the same manner as that employed for the straight-sided cutter. In using this type of cutter for interlocking, all the teeth on one cutter may be faced in one direction and all those on the other cutter in the opposite direction, using a spacing collar and spacing shims for obtaining adjustments. For milling inside faces or slots, it is advisable, if there is room, to use two interlocking cutters of either the straight-sided or staggered types rather than one cutter, for by properly adjusting the distance between the cutters on the arbor, the desired width can be more easily obtained. In regrinding a single cutter, it is customary to place the cutter on the grinding machine arbor and regrind the blades after they have been set ahead and reclamped. Such a cutter may run very true in the grinding machine, but when placed on an arbor in the milling machine it may run out and cut large. This difficulty may be overcome by grinding the cutter on the arbor taken directly from the milling machine. The cutter will then be ground while in the same position that it will occupy while in the machine, thus producing a true running cutter.

TABLE 5. INSERTED-TOOTH FACE MILLING CUTTERS FOR THREADED SPINDLE



Dia. of Cutter, Inches	No. of Teeth	A, Inches	C, Inches	D, Inch	E, Inch	F, Inch	G, Inch	Pins, Inch
5	14	4 1/2	1 15/16	0.261	5/8	1/4	7/8	5/16
6	16	5 1/2	2 7/16	0.314	5/8	1/4	7/8	5/16
7	18	6 1/2	2 7/8	0.366	3/4	5/16	1	3/8
8	20	7 1/2	3 3/8	0.418	3/4	5/16	1	3/8
9	22	8 3/8	3 27/32	0.470	3/4	5/16	1	3/8
10	24	9 3/8	4 9/32	0.523	13/16	3/8	1 1/8	7/16
11	26	10 3/8	4 25/32	0.575	13/16	3/8	1 1/8	7/16
12	28	11 3/8	5 9/32	0.625	13/16	3/8	1 1/8	7/16

Machinery

The inserted-tooth face-milling cutter, as shown in the illustration accompanying Table 3, is another type which is useful and can be employed on almost any class of face- or slab-milling. The blades are set at an angle which produces a shearing cut similar to that produced by the stagger-sided cutter. This cutter operates with a minimum amount of chatter. The inserted-tooth face-milling cutter shown in the illustration accompanying Table 4 is a type which has a shank that fits the tapered hole in the spindle of either a vertical or a horizontal milling machine, while that shown in the illustration accompanying Table 5 has a hole which is threaded to suit the nose or spindle end of either a vertical or a horizontal milling machine. These face- or end-milling cutters may be used for almost any kind of end-facing operations. In using a continuous circular milling fixture on a vertical milling machine, these cutters will also give very satisfactory results.

* * *

STUDENTS' COURSE FOR GRADUATES OF TECHNICAL SCHOOLS

For a number of years the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., has been training college graduates for its commercial and engineering departments. Well qualified men are selected for definite work and are trained by intensive methods for such predetermined positions. Emphasis is laid on the selection of men with the proper characteristics for the line of work they desire. For some types of work certain characteristics must predominate and for others these particular characteristics are not so important. The basic qualities of character are considered rather than experience or skill. One point on which stress is laid is the necessity of an early determination of the kind of work desired, as a means of avoiding waste of time and in order to get the proper preparation for the ultimate position.

Specific intensive training is given for commercial, design, manufacturing, and application engineering. The student is segregated for some particular branch as soon as he demonstrates his fitness and expresses a desire for this particular work. The course covers a period of approximately twelve months, which is divided into shop experience and intensive study. During the first period of the course there are short assignments in different manufacturing sections, bearing a definite relation to the position in which the man will ultimately be placed, and weekly class conferences accompany this shop period. This shop training is followed by a short period of full-time intensive study adapting the student to the particular work in which he is to be engaged. This is conducted under the immediate supervision of the department heads. After completion of the intensive study period, the student is taken into the regular organization of the company in the department for which his entire training has been shaped to prepare him.

* * *

SUMMER MEETING OF THE SOCIETY OF AUTOMOTIVE ENGINEERS

The summer meeting of the Society of Automotive Engineers was held at Ottawa Beach, Mich., June 23 to 27. It was one of the biggest meetings of the society, and a great many features made it both interesting and valuable to the visiting members. Besides the usual professional sessions, there was an exhibit of tanks in action and more than a million dollars worth of other ordnance automotive equipment. There were also several German war trucks, surrendered under the armistice terms and just received in this country. These trucks have steel tires and many other novel features that proved of great interest. Four separate sessions were held during four consecutive days—one devoted to trucks and fuel, one to passenger cars, one to engines and tractors, and one to aircraft and tanks. In addition, there was a lecture on wireless telephony, accompanied by a demonstration, by E. H. Colpitts, assistant chief engineer of the Western Electric Co.

NOTES ON BABBITT AND BABBITTED BEARINGS[1]

BY JESSE L. JONES[2]

Bearings fail because of warping or deformation; hence tenacity is desirable in a bearing metal, especially at high temperatures. The Brinell test is commonly regarded as a measure of tenacity; in fact, it has recently been proposed to substitute for the term Brinell hardness number the expression tenacity number. Brinell tests at progressively increasing temperatures showed that the lead-base babbitt has a better resistance to deformation at the working temperatures than babbitts with a tin base. The tests were made on disks 4 inches in diameter and 1½ inch thick of the following composition:

Babbitt	Antimony, Per Cent	Copper, Per Cent	Lead, Per Cent	Tin, Per Cent
A.........	8	2	0	90
B.........	8 1/3	8 1/3	0	83 1/3
C.........	14	0	78	8

The disks were heated by an electric hot plate, the temperature being controlled by suitable rheostats. Pyrometer leads were soldered in the center of each disk. The disks were well insulated to prevent radiation loss and were held at the desired temperature for several minutes to guard against variation. The tests were made on the bottom surface of the disks after a light machine cut was taken to secure a perfectly planed surface. The Brinell hardness numbers obtained at the various temperatures were plotted and the results are shown by the curves given in Fig. 1. At 35 degrees C. the hardness of the babbitts A and C is identical, but above this temperature the lead-base babbitt has the higher hardness number. The curves of babbitts B and C are almost parallel and not very far apart. Complete results from various test floors, covering a number of gears and a variety of motors, confirm the superiority of the lead-base babbitt. In one case where it was necessary to reline one hundred bearings containing babbitt A in a month, it was necessary to reline only about six bearings that contained the lead-base babbitt C. As a result, the lead-base babbitt was substituted for all classes of machines and the tin-base babbitt A eliminated altogether.

[1]Abstract of a paper read at the Institute of Metals Division of the American Institute of Mining Engineers.
[2]Metallurgist, Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

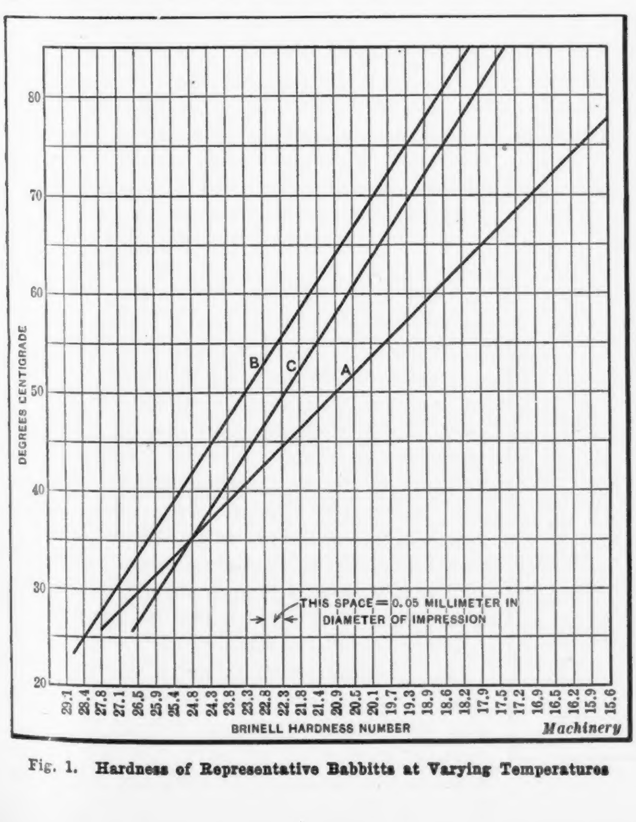


Fig. 1. Hardness of Representative Babbitts at Varying Temperatures

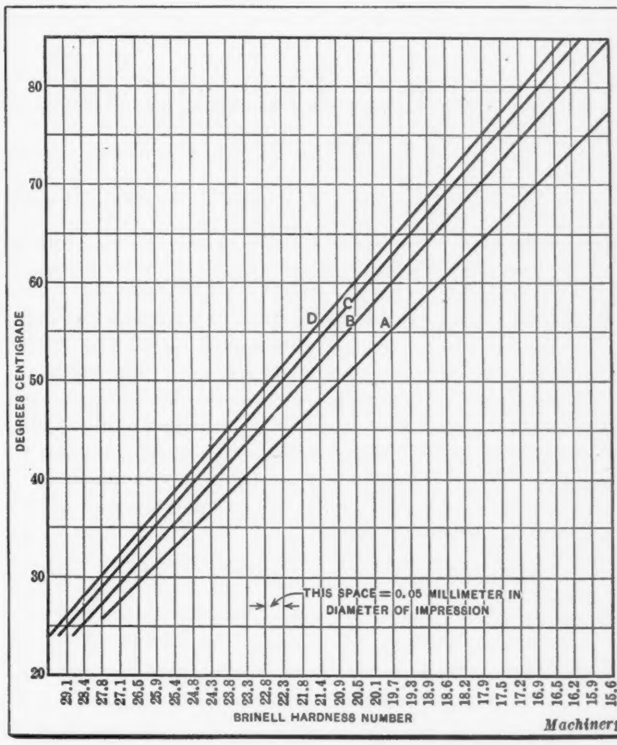


Fig. 2. Effect of Lead on Hardness of a Babbitt

While the Brinell hardness shown in the chart for the babbitts A and C is not far from the average hardness found for these alloys when using the standard hardness test piece, the results obtained for the hard babbitt B is much below the normal. This probably is due to the difficulty of preventing the large amount of copper in this babbitt from segregating even when kept very hot and being stirred continuously. The copper falls to the bottom of the melting pot; hence when stirring, the aim should be to bring the metal from the bottom of the pot to the top.

Effect of Lead on Babbitt

It is a common belief that the addition of even a small amount of lead to a genuine babbitt renders it inferior. Fig. 2 shows the results of tests made with the tin-base babbitt *A* to which has been added 1, 3, and 5 per cent of lead, the results being shown by curves *B*, *C*, and *D*, respectively. These results show that when a small amount of lead is accidentally added to the tin-base babbitt its hardness and anti-frictional qualities are much improved.

Effect of Compression on Brinell Hardness of Babbitt

In the case of large bearings, peening or compressing the babbitt by means of hammering is often specified, it being supposed that by just compressing or densifying the babbitt and hardening it the bearing will give better service. In one case where two phosphor-bronze plates were coated with babbitts B and C, then subjected to pressures varying from 8500 to 13,000 pounds per square inch, it was found that the lead-base babbitt stood up better than the tin-base babbitt. When the load was increased to 30,000 pounds per square inch, the tin-base babbitt presented a better appearance, as it flowed uniformly over the edge of the bronze square in all directions, while the lead-base babbitt was compressed more on one side than on the other. The tests show that broaching, peening, etc., do not appreciably increase the hardness of babbitt; hardness must be obtained through quickly cooling the babbitt lining by means of water-cooled mandrels, etc. A microscopic examination of a lead-base babbitt shows that the metals tend to segregate. This lack of uniformity may be guarded against by pouring a thin lining and chilling quickly. The secret of obtaining good bearings consists in keeping the matrix tough and hard. There is less tendency for tin antimonide crystals in tin-base babbitts to rise to the surface, because of the lower gravity of these babbitts.

Improved Design of "Not Go" Thread Gages

By H. L. VAN KEUREN, Engineer in Charge of Gages, Wilton Tool & Mfg. Co., Boston, Mass.
and
I. H. FULLMER, Assistant Physicist, Bureau of Standards, Washington, D. C.

A RESULT of the experience gained during the recent military preparations by American engineers and manufacturers is a more extensive and intelligent use of gages, particularly thread gages. It has been the custom to use thread gages having certain clearances provided, but the requirements making these clearances desirable or necessary have not been generally understood. It has been the practice to make the "Not Go" thread gage to the U. S. standard form, or with the crest of the thread removed, and the root of the thread cleared below the position of the flat on the U. S. standard form, so as to insure that the gage will contact with the sides of the thread of the work and not with the crest or root. The "Not Go" gage should check the pitch diameter only; therefore the thread form of the "Not Go" gage should be modified to meet this condition.

A design for a "Not Go" thread gage as shown at *A* in Fig. 1, which is easy to make and which will cost less than the present form, is suggested by the Bureau of Standards. The design embodies correct principles and will have a wearing life sufficient to meet shop conditions. In order that the principles upon which this gage is based may be clearly understood, the conditions necessary for clearance as they may be attained in practice, as well as the ideal conditions desirable in a system of "Go" and "Not Go" U. S. standard thread gages, will first be discussed.

Usual and Ideal Thread Forms for Gages

The thread form of the "Go" plug or ring thread gage which would best fulfill requirements, is that of the perfect U. S. standard thread—that is, a thread having an angle of 60 degrees, with the sides straight and the crest and root of the thread truncated at one-eighth the depth of the sharp V-thread, as shown in the illustration at *B*. Work made to fit such a "Go" gage would not, on any of its diameters, extend beyond the limits established by that gage. In the manufacture of a thread gage, it is difficult to maintain an accurate form at the root of the thread, and it is therefore the usual practice to clear out the root below the specified position of the U. S. standard flat. This practice facilitates the lapping of the thread, since it is practically impossible

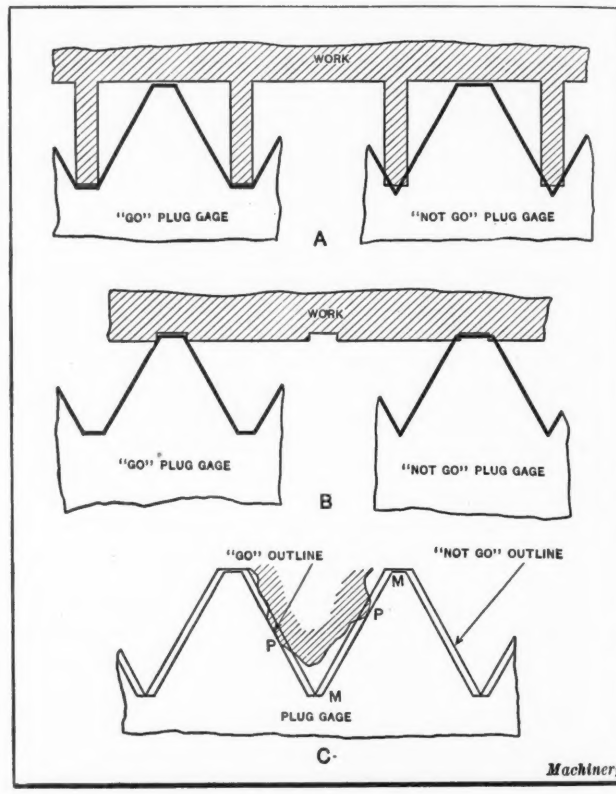


Fig. 2. Graphic Illustration of the Objection to Gage Threads that have Clearance only at Crest and Root

to lap the flat at the bottom of the thread shown at *B* and at the same time to lap the sides of the thread accurately. If the root of the thread is cleared with a sharp 60-degree tool, the gage will have the appearance shown in diagram *C* at *a*, since the lap wears away the sides of the thread without affecting the root. To avoid this, the practice of clearing the thread with a sharp 30-degree tool is recommended; the resulting form is shown in diagram *C* at *b* and *c*. Excessive clearance, as at *d*, should be avoided so the thread form above the usual position of the standard flat will not be changed. This practice is to be applied to both plug and ring gages.

Since the pitch diameter is the important dimension of a screw thread, the "Not Go" gage should be made as a gage for that diameter only. A gage made for this purpose would have a very short gaging surface at the position of the pitch diameter, the crest of the thread being removed down to a point a short distance above this position, and the root being cleared from a point just below this position. A thread having this form is shown in the illustration at *D*. Owing to the small gaging surface, such a gage would not wear long; hence, it is necessary to modify this form.

It has been the practice of the United States Ordnance Department to make the "Not Go" gage with the crest of the thread removed and the root of the thread cleared to insure that the gage would make contact only on the sides of the thread of the work and not at the

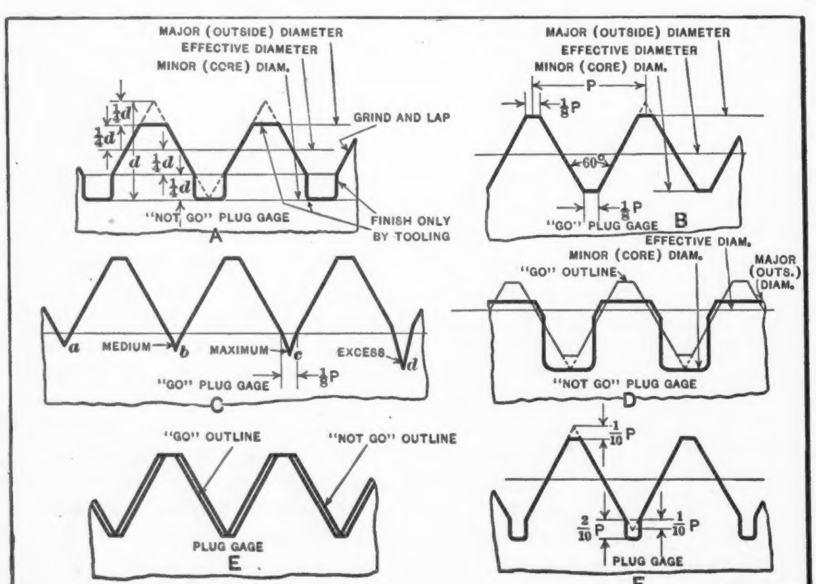


Fig. 1. Diagram of Various Thread Forms for Thread Gages

crest or root. This condition is established by making the major (full) diameter and the minor (core) diameter of the "Not Go" plug gage the same or slightly less than the corresponding diameters of the "Go" plug gage, and by making the diameters of the "Not Go" ring gage the same or slightly greater than the corresponding diameters of the "Go" ring gage. The resulting form of thread is shown in diagram *E*. The objection to this form of thread is that the thread angle of the work may be considerably in error, and yet the work be passed by gages made in accordance with the above practice. This may best be shown by the exaggerated cases presented in Fig. 2, where it may be seen that the threads having the forms shown at *A* and *B* may pass the gages; that is, the "Go" gage will enter and the "Not Go" gage will not enter the work. Further, a thread having any irregular form, as shown at *C*, and having only two points *P* which lie within the limits established by the "Go" and the "Not Go" gages, that is, within the areas *MM*, will pass the gages.

Suggested Thread Form for Gages

To overcome this difficulty, the thread form illustrated in Fig. 1 at *A* is suggested. The crest of the thread is located at about one-fourth the depth of the sharp V-thread above the pitch diameter line, and the thread groove is widened to a square shape at a distance of one-fourth the depth of the sharp V-thread below the pitch diameter line. This leaves sufficient gaging surface to provide against wear, and the amount the thread in the work may deviate from the correct outline is considerably reduced. In making this form of gage, the major or outside diameter, and the minor or core diameter, need not be kept within close limits and need not be finished by grinding and lapping after hardening. It is necessary to finish-grind and lap only the pitch-gaging surfaces. It is suggested that no clearance be given the gage at the bottom of the sharp V-thread, as indicated by the dotted outline shown in diagram *A*. The practice outlined is recommended for both "Not Go" plug and ring thread gages.

In order to determine the pitch diameter of a ring thread gage, it is customary to fit it to a threaded check-plug made to the correct pitch diameter. It is recommended that the thread form of such a check be the same as that illustrated at *A* for the "Not Go" thread gage. To insure clearance of the thread ring gage at the major diameter, a cast of the thread should be examined by the projection lantern, as explained in a later paragraph. If such a lantern is not available, the clearance should be tested by means of a threaded check plug, having a major diameter of the "Go" or maximum size, and having the angle relieved so that it will not bear on the sides of the thread in the ring gage, but at the crest only. This check plug can be used to inspect the clearance of both the "Go" and the "Not Go" thread ring gages, if the angle is sufficiently relieved. The core diameter of a "Go" ring gage should be checked with a plain plug gage. If the "Not Go" ring gage is made according to the practice here recommended, it will not be necessary to check its core diameter.

Clearance on Gages Having Other than U. S. Standard Thread Forms

Löwenherz Thread Gages—The considerations treated in this article apply in the same way to thread gages having the Löwenherz thread form, since this form differs essentially from the U. S. standard merely in that the thread angle is 53 degrees 8 minutes instead of 60 degrees.

Briggs Standard Pipe Thread Gages—In order to insure a tight joint, that is, bearing on the sides of the thread, in fittings having the Briggs standard pipe thread, the practice of reducing the crest and of clearing the root of the thread of the gage is recommended. For example, if the plug gage is made with the full form thread, it may bear in the work at the crest or root, and accordingly the gage will not enter until there is bearing on the sides of the thread, and the gage would indicate that the effective diameter of the fitting is smaller than its actual dimensions. For general practice it is recommended that the crest of the thread on the gage be removed to a depth of one-tenth the pitch, and the root be cleared to a point one-tenth the pitch above the bottom of the sharp V-thread, as shown at *F*, Fig. 1. This practice has been recommended by the committee of manufacturers on standardization of fittings and valves.

Application of the Projection Lantern for Determining Clearance and Thread Form

The optical projection lantern affords a means by which thread form and clearance of thread gages can be easily and quickly determined. The design and specifications of the projection lantern used by the Gage Section, Bureau of Standards, are available in Bureau of Standards communication B 510. A lantern of simpler design and cheaper construction, especially adapted for use in manufacturing plants, is being developed at the present time, the specifications for which will be available in the near future. By means of the lantern, the thread form and clearance are best determined by a comparison of the projected magnified shadow with templets or charts on which are drawn the correct forms of threads. These charts are enlarged as many times, compared with the exact thread form of a given pitch, as the shadow projected by the lantern is magnified. The magnification of the lantern can be determined by measuring the projected shadow of a wire or small plug of a known size. The root of a thread is very often rounded out. If the points at which the curved portion is tangent to the straight sides of the thread, are above the position at which the standard flat would be located, then the thread is not clear. The thread form and the angle of a threaded ring gage may be inspected by examining a cast of the thread made by pouring a fused mixture of about 90 per cent sulphur and 10 per cent graphite into the thread. Unless the ring is very small, the cast can be readily removed after cooling.

* * *

USE OF BALLS IN MEASURING

By G. C. HANEMAN

Toolmakers and machinists having work to do which involves accurate measurement of the location of angular parts are more or less familiar with the use of cylindrical measuring blocks, or rollers. When it is impracticable or impossible to use rollers, close results may be secured by using accurately finished balls, the mathematics required being about the same. It is the object of this article to study a few applications of the use of balls in making accurate mechanical measurements.

In this connection it is well to remember that steel balls vary a great deal in accuracy. It is, however, possible to obtain balls which are accurate to 0.0001 inch in diameter and sphericity, and these of course are to be preferred. In fact, the accuracy required in the results may demand that the balls be practically perfect. In using balls for accurate measuring, it must also be borne in mind that only a light pressure should be applied to the ball, for it is easy to vary the measurement from a few ten-thousandths to a thousandth inch or more, by increasing the pressure, and thus obtain an incorrect result. This can be demonstrated by measuring a steel ball, especially a small one, with the ordinary micrometer.

A problem which frequently occurs and one which enables a ball to be used to good advantage is illustrated at *A* in Fig. 1. The piece *a* is a taper ring gage, which must have the diameter at the large end of the hole exactly to size. A ball *b*, of suitable size, is dropped into the gage and the measurement *c* is taken by some suitable means. The diameter of the gage at the circle where the ball touches is $2r \cos d$, where r = radius of ball, and d = one-half included angle. The distance *e* from this circle to the top of the ball is $r + r \sin d$, or $r\,(1 + \sin d)$. Subtracting dimension *c* from this measurement *e*, gives the distance *f* from the circle of contact to the face of the gage. Adding $2\,(f \tan d)$ to the

contact circle diameter gives the diameter of the large end of the hole, provided, of course, that the taper is correct. By employing a similar process the diameter of the hole at the small end may also be determined.

If the diameter of the gage is large, or if a ball of the right size is not available, or if it is desired to check two or more diameters for roundness, two balls of the same size (using Johansson gages between them) may be used as illustrated at *C*. The diameter of the contact circle and its distance from the gage face are figured in practically the same way as in the case shown at *A*, except that the thickness of the Johansson gages must, of course, be added, in order to obtain the desired diameter. The methods shown at *A* and *C* may also be used for checking the taper of the hole, by using two or more sizes of balls, and measuring their respective contact circles, and then determining whether these circles are the correct distance apart, corresponding to the difference in their diameters.

An interesting application of the ball principle in checking an awkward dimension is shown in the illustration at *D*. The gage *a* is used for checking the distance of an angular oil-hole from the end of a piston-pin. The piston-pin is laid in the half-round groove with the angular pin in the oil-hole, and the length to the end of the pin is checked by the "Go" and "Not Go" shoulder plug *c*. To check dimension *d* on the gage, a ball is laid in the half-round groove, touching the angular pin as shown, and the measurement *e* is taken over the plug *j*.

Then

$$f = r \cot\left(\frac{90 \text{ degrees} - g}{2}\right)$$

and

$$k = \frac{h}{2 \cos g}$$

Subtracting the sum of r, f, k, and one-half the diameter of plug j from e leaves the required dimension d.

At *B* is shown the treatment of a case in which it was required to make a threading tool, with its point exactly on the center line. Two parallels *c* and block *d* are clamped together on a surface plate, and two balls *b* are placed in the corners as shown. By sliding the tool forward until it touches both balls on the front angular faces and checking

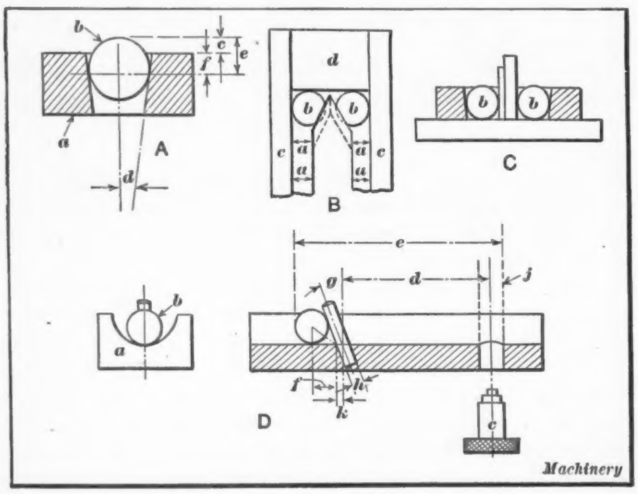


Fig. 1. Methods of using accurately Finished Balls for checking Gage Measurements

dimensions *a* with Johansson gage-blocks, it can be accurately determined if the point is central, or the exact amount, if any, that it is off center. Of course, the two angular faces must have first been ground to the same angle with the sides and bottom.

The illustration at *A*, Fig. 2, shows a method of using balls in construction. It is required to set the cylinder *a* exactly central with the conical face of ring *c*, which is not true on its inside cylindrical surface. Three balls of the same size are laid between the surface of the cylinder and the conical surface of the ring. These balls are shown opposite each other in the illustration, but they should be spaced about 120 degrees apart. The cylinder is then tapped to and fro until the measurement *d* (taken over each of the three balls) to the base, is the same. The cylinder is then central.

A flush type gage for checking the length of a projecting pin having a beveled end is shown at *B*, Fig. 2. This gage is

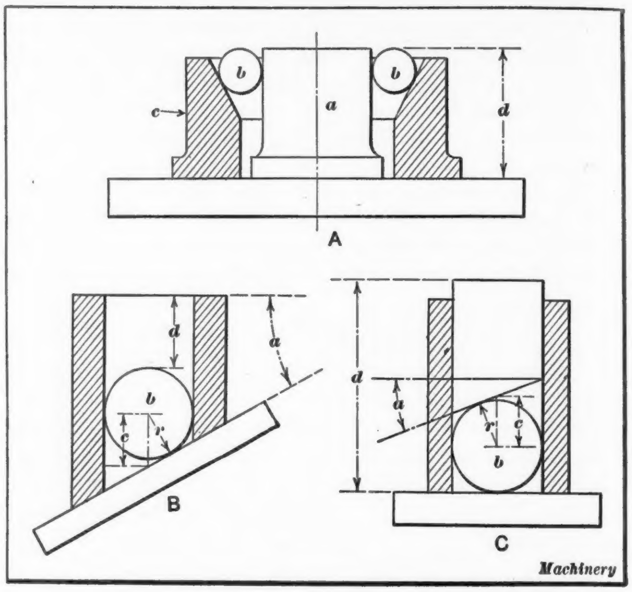


Fig. 2. Other Instances where Balls can be used to Advantage in locating and gaging

checked by clamping the beveled face of the gage against a surface plate, dropping in a ball, and measuring *d*. Then,

$$c = \frac{r}{\cos a}$$

and the length of the center line of the gage equals $d + r + c$. In the case illustrated, the ball used is the same size as the bore. With care, however, a smaller ball could be used, making it possible to check odd diameters, as balls are usually made in standard sizes only.

Another adaptation of the use of measuring balls, which is somewhat similar to the previous problem, is the checking of a round straight rod which has one beveled end, as shown at *C*. To accomplish this, a hole of the same size as the rod is bored in a block, which is faced square with the hole. The block is clamped to a faceplate, a ball dropped in, and the rod set into the hole, resting on the ball.

In this case, as before,

$$c = \frac{r}{\cos a}$$

The length of the center line of the rod is therefore equal to $d - (c + r)$.

An examination of the principles underlying these few simple problems will enable one to overcome difficult measuring propositions, which occasionally occur, by the use of accurate balls and ordinary shop trigonometry.

* * *

CORROSION OF STEAMSHIP PROPELLERS

A British research committee states that the reason steamship propellers, especially those of fast vessels, become pitted over a portion of their surface is because of what is called "cavitation" in the water—theoretically, the propeller bores holes in the water. Violent eddies tend to form in the cavitated region, especially if the propeller is revolving in water disturbed by the action of other propellers or by portions of the stern frame, and these eddies are likely to collapse suddenly, throwing the water against the propeller with a hammer-like action. Calculations showed that the weight of the blow might be several tons, or even hundreds of tons per square inch. This theory is confirmed by the fact that on a fast cruiser the bearings close to the propeller make a deafening noise.

LETTERS ON PRACTICAL SUBJECTS

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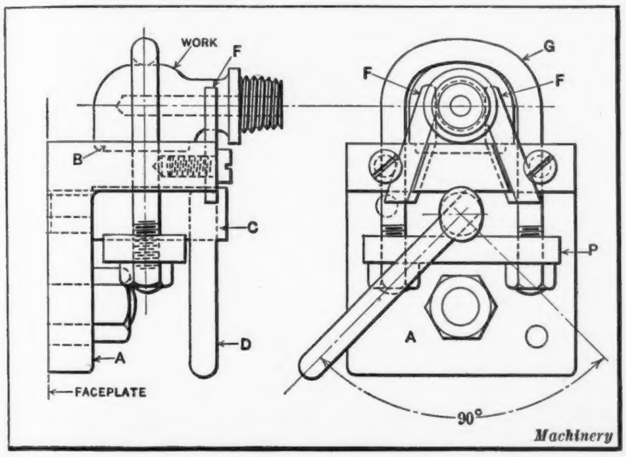
JIG FOR MACHINING BRASS ELLS

The jig shown in the accompanying illustration was designed for turning, threading, and boring brass ells such as shown clamped in position in the illustration. A number of these ells were to be made, and it was required to have the threaded nose at right angles with the previously faced and shouldered seat on the opposite end of the ell.

Referring to the illustration, *A* is a cast-iron angle-plate which is counterbored at *B* to receive the shouldered and faced projection of the ell. The work is clamped in place by means of the oval stud or cam *C*, actuated by the cam-lever *D*, which operates the inverted U-bolt *G* and secures



Jig for turning, threading, and boring Brass Ells

the ell in the socket at *B*. When loading the jig, the oval stud *C* is entirely withdrawn, enabling the U-bolt with its clamping plate *P* to be raised sufficiently to locate the work in place, after which the stud is inserted and the cam-lever *D* given a quarter turn, thus drawing the bolt down and clamping the work. Sliding fingers, such as shown at *F*, may be added if necessary to keep the work from swiveling, but for this particular job the use of these fingers was found unnecessary, as the clamping arrangement held the work sufficiently secure.

San Francisco, Cal. M. JACKER

LATHE BORING FIXTURE

A simple and inexpensive boring fixture which was designed to hold the piece shown in Fig. 2 while boring the hole *A* is shown in Fig. 1. This design may readily be in-

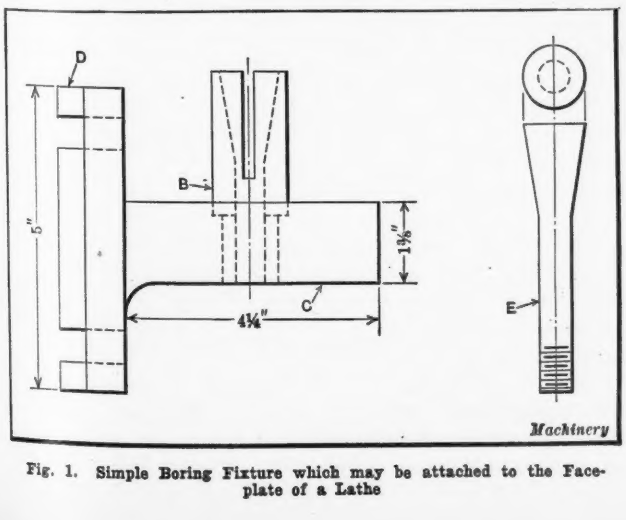


Fig. 1. Simple Boring Fixture which may be attached to the Faceplate of a Lathe

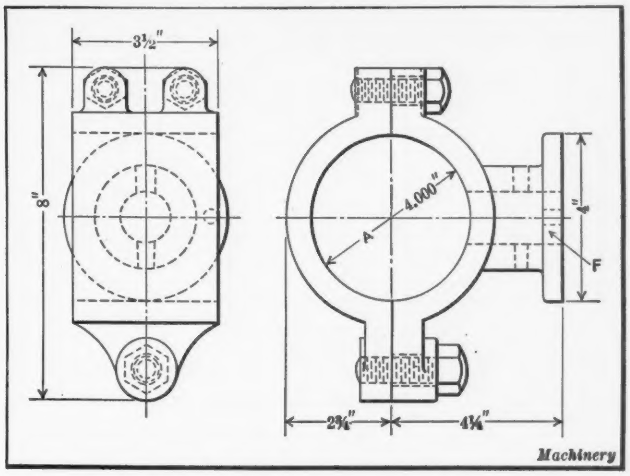


Fig. 2. Work bored on Fixture shown in Fig. 1

corporated in fixtures for holding work of a similar nature. It will be seen that the fixture consists of an angular piece *C*, which is attached to the faceplate of the lathe. The tongue *D* fits the slot of the faceplate and prevents the fixture from twisting out of position, but permits it being adjusted in or out from the center in locating the work. In the projecting part of the piece *C* is a hole into which an

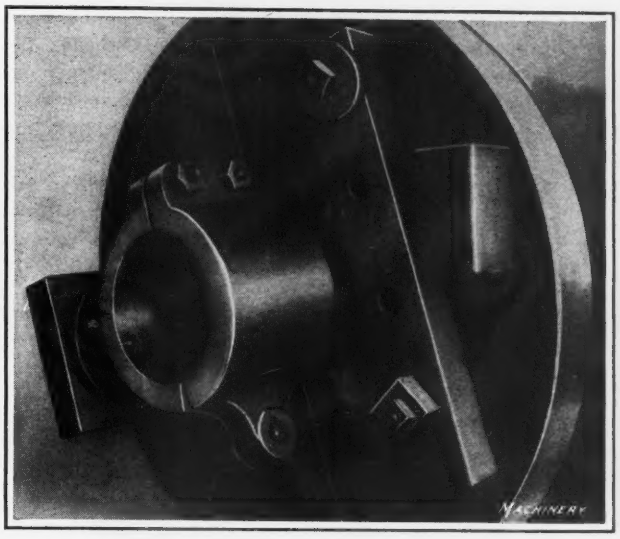


Fig. 3. Work held in Place on the Lathe Faceplate

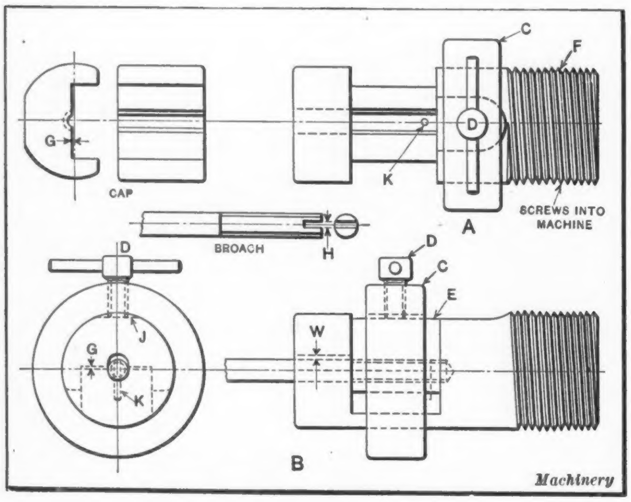
expanding bushing *B* is fitted. The bushing is slotted and may be expanded by drawing in the hardened expansion bolt *E*, which is ground to fit the taper in the bushing. The outside of the bushing is a running fit in the hole *F* of the work, Fig. 2, so that a slight expansion of the bushing will hold the work securely. Fig. 3 shows the fixture in use, with the work in position on the faceplate.

Scranton, Pa. HARVEY MEAD

BROACHING FIXTURE

There are several well-known methods for holding broaches in broaching machines. The fixture shown in the accompanying illustration is simple in construction, may be easily operated, and will always locate the broach in the right position.

The illustration shows the fixture at *A* in an unlocked position, with the clamping ring *C* moved back, the cap



Quick-action Broaching Fixture

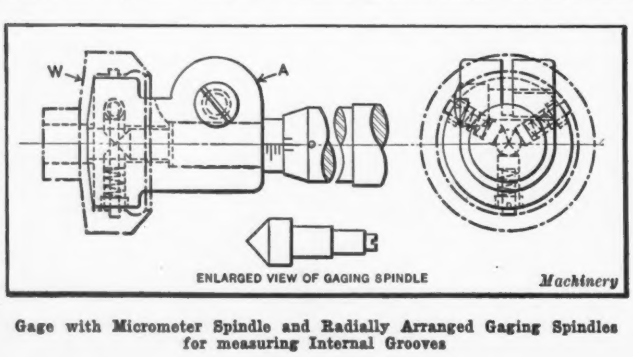
removed, and the broach withdrawn. The view *B* shows the cap in position at *E*, holding the broach by means of the ring *C*, just as it would appear when at work. The body *F* and the cap *E* are made of machine steel. It will be noticed that a section is milled out of the body into which the cap fits. By referring to the end elevation of the assembled view, it will be seen that the outline of the cap is made to conform to that of the body, and that a flat *J* is provided on the top against which the screw *D* bears. When the cap is placed in position, the ring *C* is a sliding fit over both parts. In making the fixture, the cap is assembled with the body, the hole for receiving the threaded end of the broach is tapped, and then a clearance represented by *G* is provided so that the pressure produced by screw *D* holds the broach securely in place. The outer end of the tapped hole for the broach is provided with a clearance as represented in the illustration by *W*, so that the broach may be lifted up and removed after the collar has been released and moved back. This feature eliminates the necessity of unscrewing the broach the entire distance, and thus saves much time. The broach is slotted as shown at *H*, and a pin, which engages this slot for locating the broach is provided in the body as shown at *K*.

It is not necessary to use a gage in connection with this fixture to locate the broach properly. This fixture is particularly adaptable for use on small work. On such work it is preferable to have a fine-pitch thread for the broach, which will give greater strength through increasing the area of the cross-section at the root of the thread.

Watervliet, N. Y. D. R. Gallagher

MICROMETER INTERNAL-GROOVE GAGE

The micrometer gage shown in the accompanying illustration was designed for measuring the depth of internal grooves in such work as shown at *W*. It consists of a standard micrometer head, which is fitted in the spindle bearing *A*, and provided with suitable means of adjustment. The bearing is made of cold-rolled steel, pack-hardened, and the diameter of the lower end is made to fit the bore of the work, as shown. There are three radial holes in this end,



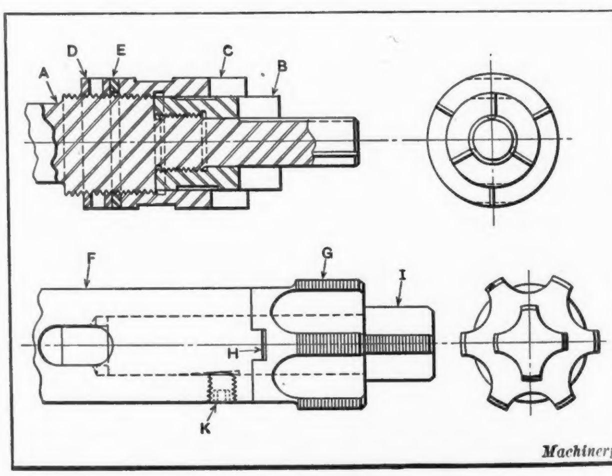
Gage with Micrometer Spindle and Radially Arranged Gaging Spindles for measuring Internal Grooves

the center lines of which coincide with that of the groove in the work to be gaged. The cone-pointed gaging spindles, shown in the enlarged view, are made of hardened drill rod and are assembled in the holes, together with the coil springs which actuate them, and enclosed by headless set-screws. These screws have a hole drilled in them through which the small end of the gaging spindles may protrude and enter the groove in the work. When the micrometer spindle is turned, its conical end forces these three spindles radially outward against the action of the springs, and the depth of the groove may then be read directly from the micrometer. The angles of the micrometer spindle cone and of the gaging spindles are the same—90 degrees—so that the lines of contact between the conical ends will be parallel. This condition is, of course, necessary if satisfactory results are to be obtained. The work may be quickly gaged by the use of this tool, which owing to its simple construction, may be easily made. On work requiring a high degree of accuracy, the results obtained with the use of this device have proved very satisfactory.

Buffalo, N. Y. Herman Kurzweil

SPECIAL TOOLS FOR FACING AND TAPPING

The tools shown in the accompanying illustration were designed to increase production. Each tool is used to machine two surfaces in one operation, thus accomplishing



Special Tools for Facing and Tapping

work that formerly required two tools and two operations to complete it. The tool shown in the upper half of the illustration is designed to finish-face two surfaces in a counterbored hole that are required to be a given distance from each other within close limits of accuracy. The main body *A* is made of machine steel, pack-hardened, and ground. One end fits the chuck and the other acts as a pilot in the drilled hole of the work. The pilot has three grooves milled in it to provide a clearance space for dirt. The body *A* has two threaded portions, the larger of which has twenty threads per inch which allows accurate adjustment. The facing tool *B* is similar to an ordinary hollow-mill and has three cutting edges. It is held on the pilot by means of the threads shown, and is non-adjustable. The facing tool *C* also has three cutting edges and is of similar construction. However, tool *C* has a screw adjustment on the fine threaded portion of the body, previously mentioned. The lock-nut *D* and washer *E* are employed to lock the cutter in place when properly adjusted. Both cutters or mills are made of hardened tool steel, and have two flats milled on their outside surfaces to provide means of turning them. The adjustable feature enables the distance between the two bored faces to be maintained within accurate limits.

In the lower illustration is shown a combination tap that is used for threading the work after the tool just described has completed its work. The body *F* fits into the same chuck

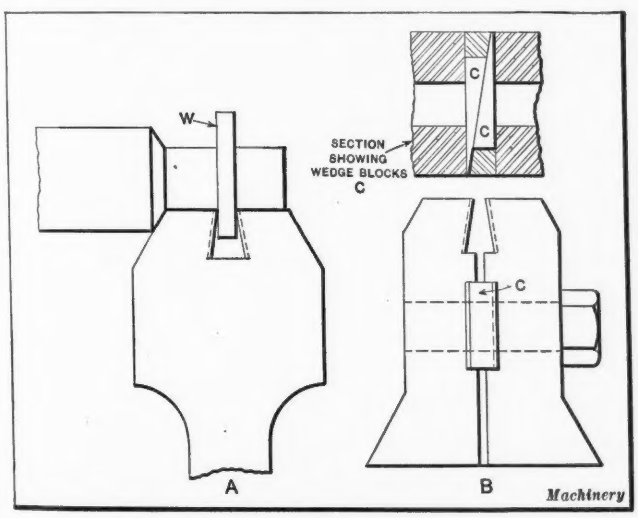
as the facing tool, and is also made of machine steel. The tap *G* is made from tool steel and has six flutes. A tongue *H* serves to drive this tap. Tap *I* has only four flutes and, of course, has the same number of threads per inch as tap *G*. The headless set-screw *K* holds tap *I* in place, and *I*, in turn, prevents tap *G* from becoming loose.

New Brunswick, N. J. C. H. DENGLER

FLANGE FORMING TOOL

On small screw machine work where it is necessary to form a flange which must be accurate as regards width, a tool similar to the one shown at *A* in the accompanying illustration is frequently used. On account of the side clearance necessary, the length of service of this type of tool is shortened, because the tool dulls rapidly, causing rough work, and consequently requires frequent grinding. As a means of prolonging the life of such tools, it is often the practice, especially when turning flanges which do not have a much larger diameter than the body of the work, to provide clearance only a short distance up from the under side of the tool. In fact, the clearance is often omitted entirely.

At *B* is shown a split type of flange tool which is a great improvement over the one-piece type. It can be readily ground and adjusted to suit the width required, no matter how often it is ground. The length of service of this tool



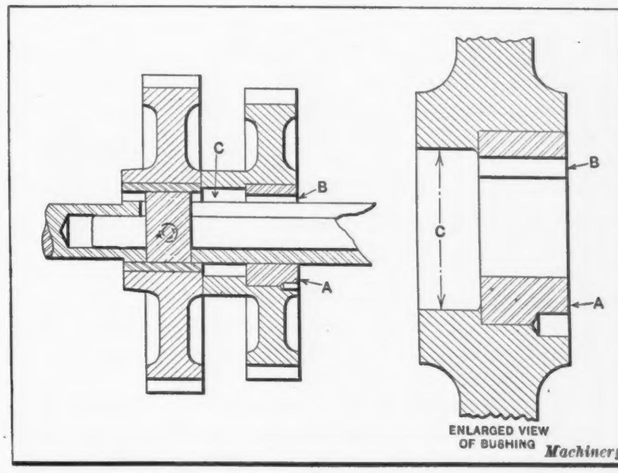
Construction of Flange Forming Tool

is, therefore, much greater than that of the tool shown at *A*. The construction should be readily understood by referring to the illustration. The two hardened and ground wedges *C* form a sizing block which may be readily adjusted for width of cut. This tool may be easily taken apart and reassembled when it is desired to grind the cutting edges. A U-shaped opening for the machine screw as shown in the sectional view must be provided in each block instead of a round hole, in order to allow for the adjustment.

Buffalo, N. Y. A. F. OWEN

KEYED TOOL-STEEL BUSHINGS FOR GRAY IRON GEARS

In designing a train of gray iron feed-gears for a plain milling machine, to replace more expensive bronze gears, the construction shown in the accompanying illustration was adopted. The design overcame an objectionable feature experienced with the bronze gears, in addition to decreasing the expense. This difficulty resulted from the steel key on the feed-change rod quickly wearing away the keyways in the gears. A hardened tool-steel bushing *A* was provided for each gear, and also a cored pocket *C* in the gear hub, of sufficient diameter to allow the passage of the key through the keyway *B*. The depth of the cored pocket was made to allow 1/16 inch clearance for the sliding key, and to form a



Gear Hub with Keyway for Feed-change Key in Tool-steel Bushing

rest pocket between each change of speed. This simple idea has successfully overcome all trouble caused from the keyways becoming worn.

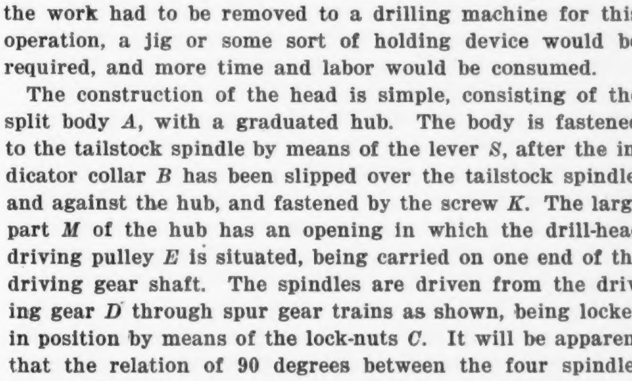
Hamilton, Ontario, Canada J. H. MOORE

MULTIPLE-SPINDLE DRILL HEAD FOR LATHE

The four-spindle drill head shown in the accompanying illustration may be used on work, in which it is desired to drill a series of holes, such as automobile flywheels. The holes may be drilled while the work is in the lathe by attaching the drill head to the lathe tailstock spindle. If the work had to be removed to a drilling machine for this operation, a jig or some sort of holding device would be required, and more time and labor would be consumed.

The construction of the head is simple, consisting of the split body *A*, with a graduated hub. The body is fastened to the tailstock spindle by means of the lever *S*, after the indicator collar *B* has been slipped over the tailstock spindle, and against the hub, and fastened by the screw *K*. The large part *M* of the hub has an opening in which the drill-head driving pulley *E* is situated, being carried on one end of the driving gear shaft. The spindles are driven from the driving gear *D* through spur gear trains as shown, being locked in position by means of the lock-nuts *C*. It will be apparent that the relation of 90 degrees between the four spindles must always remain unchanged if accurate work is to be had. The graduated hub and indicator collar previously mentioned provide for drilling work where the quantity of holes required is more than four, as for instance six, eight, ten, twelve, or in fact, any even number within the range of the head. If the number of holes to be drilled is not a multiple of four, it is possible to use only one opposite pair of spindles. For example, if ten holes are to be drilled, the first two opposite holes are drilled with the head indexed at zero, as shown in the illustration, after which the body is turned 36 degrees and the next pair drilled, and so on until five pairs or ten holes are drilled.

In operation, the lathe spindle does not revolve, of course, the head being driven independently through pulley *E*, and



Four-spindle Drill Head for Use on Lathes

the drills being fed into the work by means of the tailstock handwheel, after the head has been positioned and the drill spindles locked.

Stillwater, Minn. OTTO DORTHEN

FORMULAS FOR OFFSET CRANKSHAFT CALCULATIONS

Engines that have the center of the crankshaft located on the center line of the cylinder have a piston stroke which is exactly equal to the crankshaft stroke. On engines, the design of which provides an offset crankshaft, where the center lines of the crankshaft and cylinder do not coincide, the crank and piston strokes are not equal, the piston stroke being greater than that of the crankshaft. Referring to the accompanying illustration, S represents the crankshaft stroke, S_1 the piston stroke, L the length of the connecting-rod, M the offset of the crankshaft center, and R the throw of the crank. Centers D and D_1 represent the upper and lower dead centers of the crankshaft wrist-pin, and the full and dotted lines designated by the dimensions L show the respective positions of the connecting-rod at the end of each stroke of the piston.

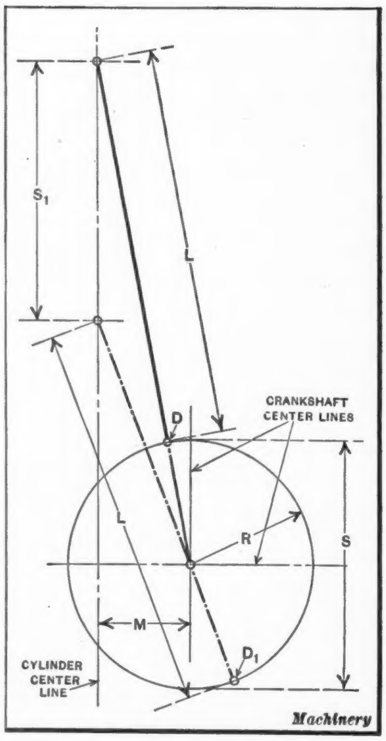


Diagram illustrating Length of Stroke of Offset Crankshaft

Then,

$$S_1 = \sqrt{(L + R)^2 - M^2} - \sqrt{(L - R)^2 - M^2}$$

Example—Assume $L = 10$ inches, $R = 2\frac{1}{2}$ inches, $S = 5$ inches, and $M = 1\frac{1}{2}$ inch. From the formula,

$$S_1 = \sqrt{(10 + 2.5)^2 - 1.5^2} - \sqrt{(10 - 2.5)^2 - 1.5^2}$$
$$= \sqrt{12.5^2 - 1.5^2} - \sqrt{7.5^2 - 1.5^2}$$
$$= 12.4097 - 7.3485 = 5.0612 \text{ inches}$$

Therefore, S_1 is greater than S.

New York City K. W. NAJDER

MACHINERY AND EQUIPMENT RECORD CARD

The writer has had several years of experience in installing machinery and equipment, and in connection with this work encountered considerable difficulty in keeping accurate records of all machinery installed until a "Machinery and Equipment Record" card index was adopted. The type of index card shown in Fig. 1 was employed, and this style of card has given very satisfactory results. Such a card enables all data concerning any machinery or equipment installed in the plant to be accurately recorded and the record to be kept in a convenient file for reference. On the reverse side of the card (Fig. 2) a record of the repair costs of the machinery or the equipment is kept, which constitutes a ready reference for determining what the cost has been to keep the machinery or the equipment in working condition. These records prove of great value when furnishing repair parts in case of breakdowns or when duplicate orders are required to be filled. For instance, one time it was desired to order a motor just like one that had been previously installed, but through years of service, the name-plate had been destroyed, and consequently such data as the serial number, size, type, voltage, etc., could not be ascertained. If a card index file had been available, this information could have been found, as well as practically all necessary data concerning the motor.

Aurora, Ill. A. H. BOEHM

INCREASING SHOP PRODUCTION

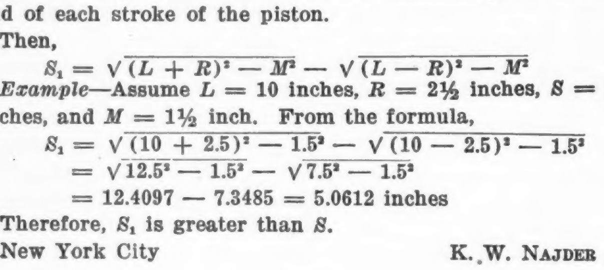
The following method of increasing shop production was successfully used in the plant of a well-known concern. A man was appointed to investigate the maximum capacity of each machine in the shop and to decide upon the maximum speed for any diameter of work, and the correct feed for any depth of cut. These results were tabulated and a separate card was made for every machine, informing the operator how to obtain the greatest output from the machine for every operation performed on it. The machine operators were watched constantly, and as soon as they turned out a certain per cent of the output decided upon as possible, they received an increase in wages, the wage rates being entirely set on this basis. The wages of new men were steadily increased at a fixed rate for a period of six months, after which they were paid the rate that their previous records showed they deserved.

The final output of a plant depends upon the output of the machining departments. No other department has as much influence upon the total production. Should other departments fall behind, these can be quickly enlarged to take care of any increase in the output. Consequently the plan outlined above should be of interest to all those responsible for shop production.

Indianapolis, Ind. STUART DEAN

PRODUCING SHEET-STEEL ARTICLES

Sheet steel may be used for practically any kind of forming and drawing operations, provided it has the proper degree of ductility and softness. When sheet steel was first used for this purpose, a certain concern experienced trouble in drawing steel cups. Some of the cups were cracked and



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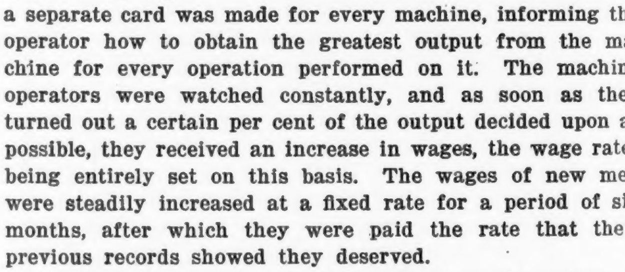
SOLD TO DATE PRICE

Fig. 1. Machinery and Equipment Record Card



REPAIR COST

DEPT.	DATE	ORDER NO.	HOURS	COST	DESCRIPTION

Fig. 2. Back of Machinery and Equipment Record Card

others had a fracture along the side, showing plainly that the steel was not adapted for that sort of work. Other steel was then used, and although the shape of the cup was satisfactory, the outside of the vessel was rough, and deep veins and seams were visible, the surface having the appearance of morocco leather. This condition was not desirable, because the surface was afterward to be plated, and required much extra work in the buffing room, a coarse wheel, then a fine wheel and finally a felt wheel being needed to make the surface sufficiently smooth for plating. One explanation for the morocco-like appearance of the exterior surface is that when sheet metal cools, the outside surface often cools too rapidly and becomes brittle, and since the internal structure of the sheet steel is softer than the external, it stretches, while the hard external structure breaks and leaves cracks in the drawn piece.

It is now possible to obtain steel which has an absolutely smooth surface and an extra bright finish after being formed or drawn, so that little work is required with a buffing wheel to prepare it for the plating bath. Steel that possesses the qualifications for drawing operations, but that does not have a smooth surface may be pickled to remove scale and rust, the operation being done either before the steel goes to the press room or after the parts are punched. Cold-rolled steel, when soft, is much better to use for drawing operations than hot-rolled steel, as the surface of the former is smooth and free from scale. Where the outside appearance of the article is of little importance, blue annealed steel will usually serve the purpose, and even common sheet iron has been used for forming and light drawing, where the finish of the part was of no consequence. By punching the steel while it is red-hot, many operations can be accomplished that are not possible when the metal is cold.

Sheet-steel articles are generally colored before being plated; this can be accomplished by the use of a sheepskin wheel which gives the steel a bright surface so that it will have a high finish after being plated, but since steel oxidizes easily, it soon loses its bright appearance, and when shipped it is generally coated with oil as a preventive against oxidation. This coating causes dust to collect, which in time hardens, so that a cyanide bath is necessary to remove it.

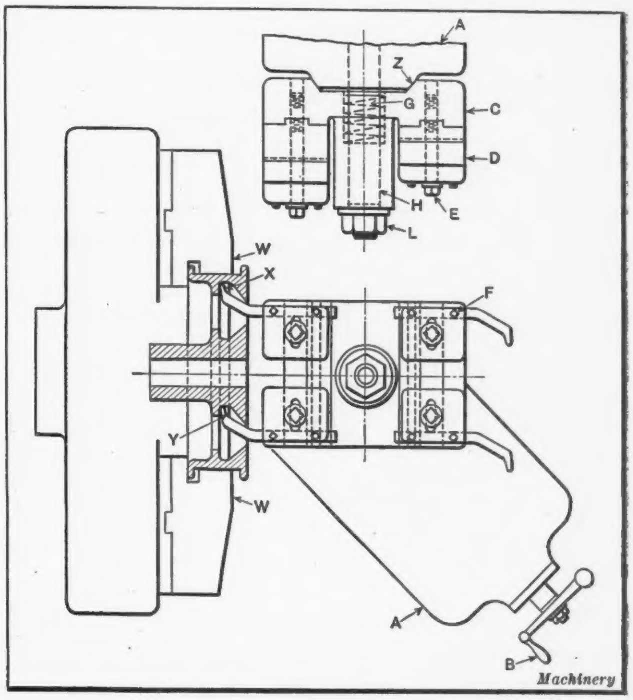
At the present time manufacturers specialize in sheet steel just as they do in many other products, and it is obtainable for deep drawing, either way of the grain as well as for light drawing, bending, or flat stamping work. Some firms grade their steel and state the capabilities of each grade, so that cutting and trying in the press room is rarely necessary. It has lately been demonstrated that with proper treatment sheet steel may be satisfactorily used for many purposes for which sheet brass and copper were formerly employed. Soft sheet steel is also used in regular production for spinning operations, and the results may be favorably compared with those obtained from the use of copper, brass, and aluminum.

Pittsfield, Mass. H. H. Armstrong

BORING FIXTURE FOR BEVELED SURFACES

The illustration shows an attachment that is used on a lathe for boring two bevel surfaces and two straight surfaces on flanged pulleys that are machined, as shown, for friction clutch arrangements. The faces and flanges of the pulleys have been previously machined and can therefore be gripped in the soft chuck jaws *W*, these jaws having been especially made for the job. It will be noticed that tool *X* bores a bevel surface and a straight surface under the rim of the pulley, while another tool *Y* performs a similar operation on a bevel surface and on a straight surface on the hub. These beveled surfaces are both at an angle of 45 degrees, and by means of the compound rest of the machine and the attachment provided, a roughing and a finishing cut can be taken over these surfaces without disturbing the setting of the tools.

The slide *A* was made to replace the regular slide on the compound rest, and is operated on the rest in the usual manner by means of handle *B*. On this slide a block *C* is mounted which carries four tool-holders *D*. These tool-holders have transverse adjustment on the block to regulate the relative positions of the tools, and are held in position by screws *E*, while the tools may be adjusted laterally for depth of cut, being clamped by the screws *F*. Spring *G* is held in a counterbored hole in block *C* and is compressed against slide *A* by means of stud *H* and nut *L*. The tongued seat *Z* locates the block properly on the slide. After the tools have been properly located relative to the work, the carriage is moved into position on the ways of the machine against a spacing block which is placed between the carriage and a stop on the ways. When in this position, slide *A* is fed in the required depth, thus machining both bevels simultaneously. When the correct depth is reached, the spacing block is removed and the carriage is moved laterally to machine the straight part. After the roughing cuts have been taken as described and the tools have been withdrawn from the work, the block and tools are indexed half a revolution by loosening nut *L* which allows spring *G* to



Boring Fixture for Beveled Surfaces, mounted on Compound Rest of Lathe

expand and raise block *C* so that it may be revolved the required amount or 180 degrees. The nut is then tightened on the bolt, which securely holds the block in place while the finishing cuts are being taken in a similar manner to those for roughing. By the use of this fixture production may be greatly increased.

Pawtucket, R. I. Frank H. Mayoh

HARDENING TOOL STEEL

To harden forming tools, cutters, or similar tools which require a smooth surface and at the same time which need to be very hard, satisfactory results can be obtained by the following method: The gas furnace should be raised to a temperature of about 1600 degrees F., and the gas and blast should then be shut off. Place the tools in the back heat of the furnace until they become half red, and then push them into the center of the furnace, keeping them there until the temperature falls to a little under 1500 degrees F. The tools should then be plunged in salt water. For work on softer grades of steel, the temper should be drawn to about 400 degrees F.

Worcester, Mass. E. M. Peterson

SHOP AND DRAFTING-ROOM KINKS

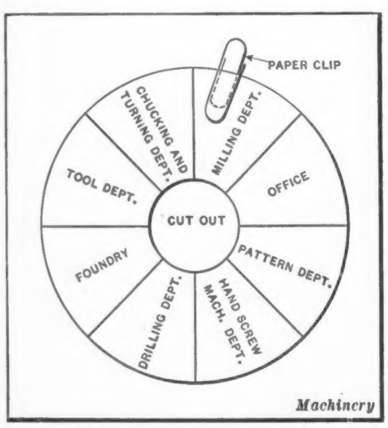
TAP KINK

When using hand taps, even those that are furnished in sets of three, the taps must be twisted back and forth in tapping a piece of steel. This twisting and wrenching considerably shortens the life of the taps, and should be avoided when possible. If the taps are ground down sufficiently so that each, when used successively, can be screwed directly through the steel without wrenching or twisting, they will be preserved for a very much longer period of time. The first tap should have the tops of all its threads ground away with a gradual taper, and each succeeding tap should be a little larger and of the same taper. A set of three or four taps, ground as stated above, will outlast the regular set, will give just as good results, and such taps are much easier on the wrench.

San Francisco, Cal. M. JACKER

SCHEME FOR DETERMINING WHEREABOUTS OF FOREMEN

A simple scheme for finding a foreman when absent from his department is shown in the accompanying illustration. The device consists of a circular disk cut from ordinary paper or cardboard and divided into suitably marked sectors as shown. The center is cut out so as to be put over the mouthpiece of the telephone, and the foreman on leaving the department simply attaches an ordinary paper clip opposite the department name to which he is going. The clerk can thus readily determine the foreman's whereabouts and upon answering the telephone can at glance furnish the desired information. In case the foreman should go from one department to another this fact should be communicated to the clerk and the clip changed to correspond.



Mouthpiece Chart for the Telephone by Means of which Foremen may be easily located

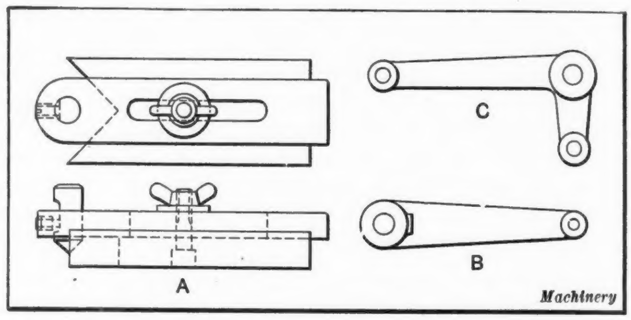
M. P. M.

A DOWELING KINK

Much of the trouble experienced in assembling parts that are doweled together may be traced to the dowel holes. Even though the holes may be carefully lapped they are likely to bulge out or to be dug into by the dowel when it is being driven in on reassembling. A simple method of overcoming this is to chamfer the holes where the pieces of work come together. This little kink will prove a great time-saver on gage and fixture work in cases where reassembling is required. H. A. T.

CENTERING FIXTURE

The centering fixture shown at *A* in the accompanying illustration was made for the purpose of rapidly locating and centering bosses of levers and bellcranks similar to those shown at *B* and *C*, respectively, previous to being drilled. As the only requirements in locating the holes were that they be centered with the bosses, the method described proved sufficiently accurate and was considered less expensive than using a drill jig. As will be seen by referring to *A*, the locating fixture consists of a body having a 90-degree vee at one end, and an adjustable punch-holder carrying a center-punch. In operation, the punch is adjusted to a distance from the sides of the vee equal to the radius of the boss to be centered, and is locked in place by means of a



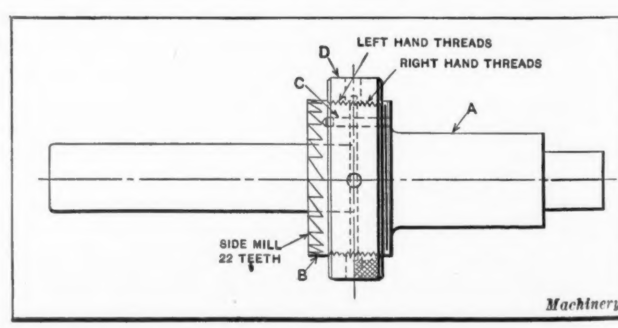
Fixture for centering Bosses on Levers and Bellcranks

wing-nut. By placing the lever under the fixture with the boss against the vee, the punch will be located in the center of all bosses of like radius.

Cincinnati, Ohio HOWARD M. BOGART

HAND FACING TOOL

The accompanying illustration shows a hand facing tool, which was used for accurately facing the ends of bearings square with the bore. The machine steel body *A* of the tool is pack-hardened and ground. One end of the body is squared for the use of a wrench and the other end is ground to the size of the bore forming the pilot for the facing cutter *B*. This cutter has twenty-two cut teeth, and is made of hardened and ground high-speed steel. The drill-rod pin *C* acts as a key for the cutter and body. The cutter and the shouldered part of the body are threaded, and after the cutter



Hand Tool for Facing Ends of Bearings Square with the Bore

is properly aligned by means of this shouldered section it is held in place by the threaded ring *D* which securely locks the cutter in place because of the opposite-hand threads. This threaded ring is knurled and is drilled for a spanner wrench.

New Brunswick, N. J. C. H. DENGLER

* * *

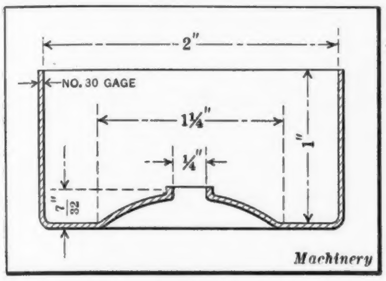
The Council of the German Industrial Standards Committee has specified that the temperature at which reference gages are to be standard shall be 20 degrees C. (68 degrees F.). It is further stipulated that the International system of screw threads and the Whitworth screw threads shall both be considered as standards in Germany.

HOW AND WHY

QUESTIONS ON PRACTICAL SUBJECTS OF GENERAL INTEREST

DRAWING A BRASS SHELL

R. W.—A cup of the dimensions shown in the accompanying illustration is to be drawn. Can any reader of MACHINERY that has performed drawing operations on cups of this or similar shape furnish illustrations and descriptions of the dies that have actually been used in performing the work? The material is brass, No. 30 gage. The tools should preferably be designed for a single-action press.



Cup-shaped Brass Shell to be drawn on a Single-action Press

CLUTCH DESIGN FOR CLOSELY SPACED SHEAVES

R. L. C.—In a space 6 inches in height, six small sheaves, 2½ to 5 inches in diameter, are mounted upon a ⅝-inch vertical shaft, driven by a ¼-horsepower motor at 175 revolutions per minute. These sheaves must be operated independently by frictional clutch mechanisms moved radially in relation to the shaft. What is the proper design for a clutch mechanism operated by a short radial movement in the ⅛-inch space that there is available between the sheaves?

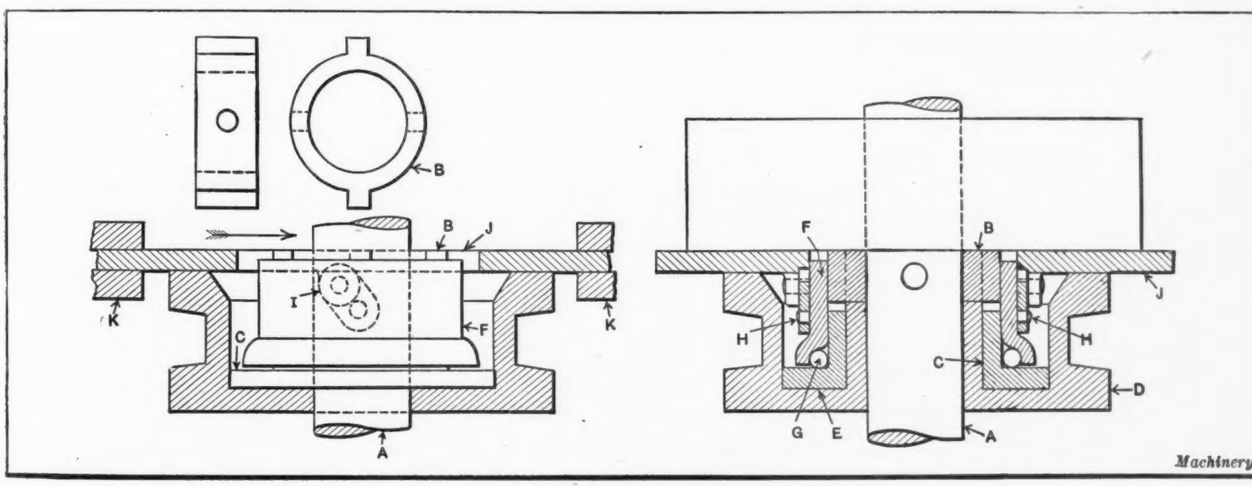
Answered by R. P. Deane, Holyoke, Mass.

The accompanying illustration shows a design for a clutch arrangement that may satisfactorily answer the question submitted to the readers of MACHINERY in the April number, page 758. In the illustration it will be noted that only one sheave and clutch, of the six required, is shown. The clutch driving collar *B*, which is pinned to the shaft *A*, has two ears serving as keys for engaging slots in the hub of the driving member, or clutch *C*. This clutch fits over the internal hub of the sheave *D* and bears against the friction surface *E* of the sheave. It will be observed that the outside diameter of the sheave hub is the same as that of the collar *B;* and also that the outside diameter of the clutch *C* is equal to the diameter of *B* through the ears. This construction allows the thrust spool *F* to slide over the two parts and, by means of a thrust ball bearing *G*, to operate the clutch against the friction surface *E*. The thrust spool is connected to lugs on the sliding plate *J*, by means of two toggle links *I* located diametrically opposite each other. Projecting pins *H* on the thrust spool are the means of connection between the links and the spool. Slide *J* is capable of sliding in the guides *K* and it will be seen that a slight movement of *J*, in the direction indicated by the arrow, will operate the toggles and exert pressure on the clutch *C* by means of the steel balls contained in the end of the thrust spool. It should be stated that the plate *J* is made wide so that it will be as stiff as is possible for it to be in such a narrow space.

The foregoing description has to do only with the clutch design. It is suggested that the clutch could be held in the driving position by means of a spring attached to the sliding plate *J*, and on the other hand, could be held in disengagement by means of a simple pawl attachment.

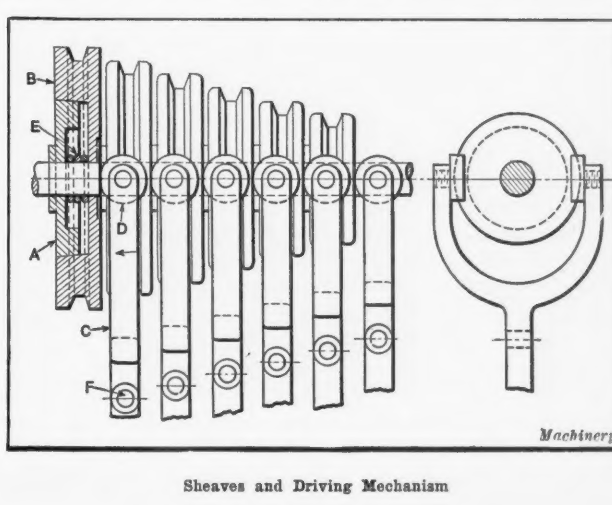
Answered by Edmund C. Persans, Brooklyn, N. Y.

The accompanying illustration shows a design for the sheave problem presented to the readers of MACHINERY on page 758 of the April number. The largest sheave, clutch, and spring are shown in section, the same design being used for each sheave, although the details are somewhat different owing to the amount of space available in the smaller sheaves. The clutch disk *A* is keyed to the shaft,



Clutch which may be operated by a Short Radial Movement

and the sheave *B* is free to revolve. When desiring to transmit power by means of the sheave, the yoke *C* is swung on its fulcrum *F*, so as to force roller *D* in the direction indicated by the arrow and bring it into contact with the side of the sheave, thus creating sufficient friction be-



Sheaves and Driving Mechanism

tween the conical clutch disk and the sheave to transmit the required power. The spring *E* will release the sheave from contact with the disk when it is desired to disengage the clutch. It is evident that with this design each sheave may be operated independently.

GLAZED AND LOADED GRINDING WHEELS

F. M.—What is the difference between a glazed and a loaded grinding wheel?

A.—A wheel is said to be "glazed" when the abrasive or cutting particles become dull and are worn down even with the bond. Glazing may indicate that the bond is too hard and that the grit is not dislodged before it is dulled excessively; or glazing may be the result of an excessive wheel speed. When the pores or spaces between the abrasive grains are filled with the material being ground, or are clogged, the wheel is "loaded." Loading may be due to a slow speed or to too hard a bond.

A TOOLMAKER'S PROBLEM

J. A.—Will you kindly show me how to find the correct diameter of a plug which will be tangent to the sides of a snap gage as shown in the illustration? The 2-inch dimension and the 15-degree angle are all that are known.

Answered by Giovanni Puccia, New York City

The following is another simple solution of the toolmaker's problem presented in the February and April numbers of MACHINERY. Draw *OA* and *OB*, which according to geometry, bisect the angles *DAB* and *EBA*, respectively. Draw *OC* perpendicular to *AB*. In the triangles *OAC* and *OBC*, side *OC* is common. Therefore:

$\tan a \times (2 - R) = \tan b \times R;$

$\tan 52$ degs. 30 minutes $(2 - R) = \tan 45$ degrees $\times R;$

$1.30323\,(2 - R) = 1R;$

$2.60646 = R + 1.30323\,R = R\,(1 + 1.30323);$

$$R = \frac{2.60646}{2.30323} = 1.13165 \text{ inch and } 2R = 2.2633 \text{ inches.}$$

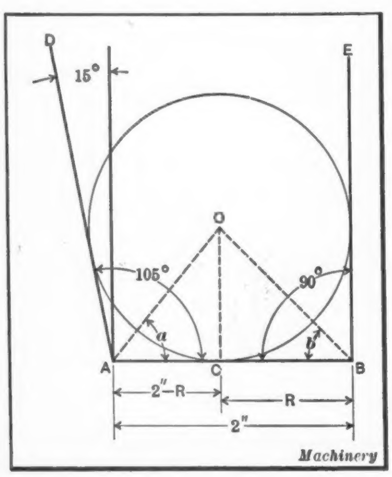


Diagram for finding Diameter of a Plug that is Tangent to the Sides of a Snap Gage

CAST IRON OR BRONZE BEARINGS FOR MACHINE TOOLS

Machine Tool Builder—The opinions of men in the machine tool trade are invited as to the relative merits of cast-iron and bronze bearings for machine tools when the spindles are made of steel, hardened and ground.

Reply by Donald A. Hampson, Middletown, N. Y.

Routing machines, such as used for photo-engraving, have a shaft for carrying the tool, which is approximately ¾ inch in diameter and which revolves at from 8000 to 14,000 revolutions per minute. The cast-iron bearings for these shafts are often unbushed. About twelve years ago, the writer made quantities of these bearings, and does not recall that they have ever been replaced; in fact, the quill bearings on the sensitive drilling machines in the shop did not apparently give as good service as the unbushed bearings on the routing machine, although the latter revolved much faster than the drill spindle and performed nearly as heavy work.

In another instance, six duplex milling machines, equipped with 2¼-inch machine-steel shafts and cast-iron bearings 4½ inches long, have rendered service which compares favorably with that of a number of machines of standard make which are installed in the same room. These standard machines are furnished with much larger bronze bearings and their shafts are made of harder steel than those of the duplex machines. The latter are about seventeen years old and have been in constant operation on accurate work at a speed of about 250 revolutions per minute for most of that time. Although the bushed bearings may be better construction, the old solid cast-iron bearings are giving equal satisfaction and performing the same type of service.

FINDING THE LENGTH OF THE RADIUS OF A TANGENT ARC

E. E. J.—How can the length of the radius of a tangent arc for a slabbed cylindrical piece be found if the radius *R* of the piece, the angle *a* at which the slab is taken, and the distance *Y* are known?

Answered by J. L. Jinkins, Benton Harbor, Mich.

Continue lines *BC* and *OA* to the point of intersection *E*. Also draw *CF* parallel to *BO* from the point of tangency *C*. According to geometry *DF* bisects angle *CFA*; therefore angles *DFA* and *DFC* equal $\frac{a}{2}$. We then have:

$$r = AF = \frac{DA}{\tan \frac{a}{2}}$$

$DA = EA \tan (90 \text{ degrees} - a)$

$EA = EO - R$

$$EO = \frac{Y}{\cos a}$$

Therefore,

$$DA = \frac{Y}{\cos a} - R \tan (90 \text{ deg.} - a)$$

and

$$r = \frac{(Y \div \cos a) - R \tan (90 \text{ deg.} - a)}{\tan \frac{a}{2}}$$

$$r = \frac{(Y \div \cos a) - R \cot a}{\tan \frac{a}{2}}$$

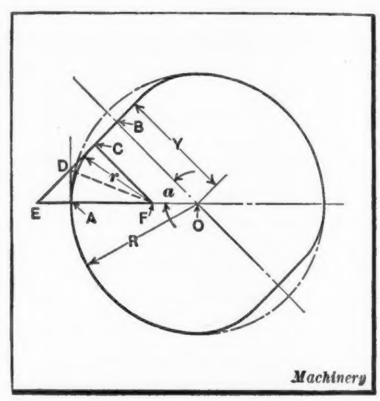
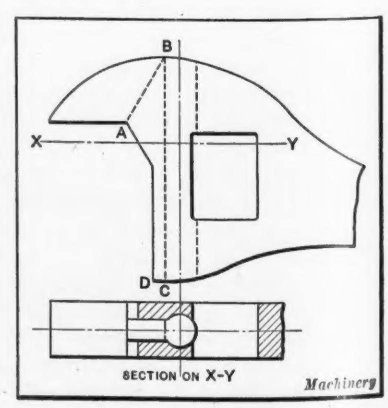


Diagram for finding the Length of the Radius of a Tangent Arc

PRODUCTION PROBLEM FOR THE MACHINE SHOP

M. M. S.—The following problem is submitted to the readers of MACHINERY. It is desired to determine the best and most economical method, on a production basis, of removing section *ABCD* (see illustration), thus forming a slot in which the movable jaw of an adjustable wrench may operate after the hole in the jaw rack has been drilled.



Wrench Head in which Slot is to be cut for Movable Jaw

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW AMERICAN METAL-WORKING MACHINERY

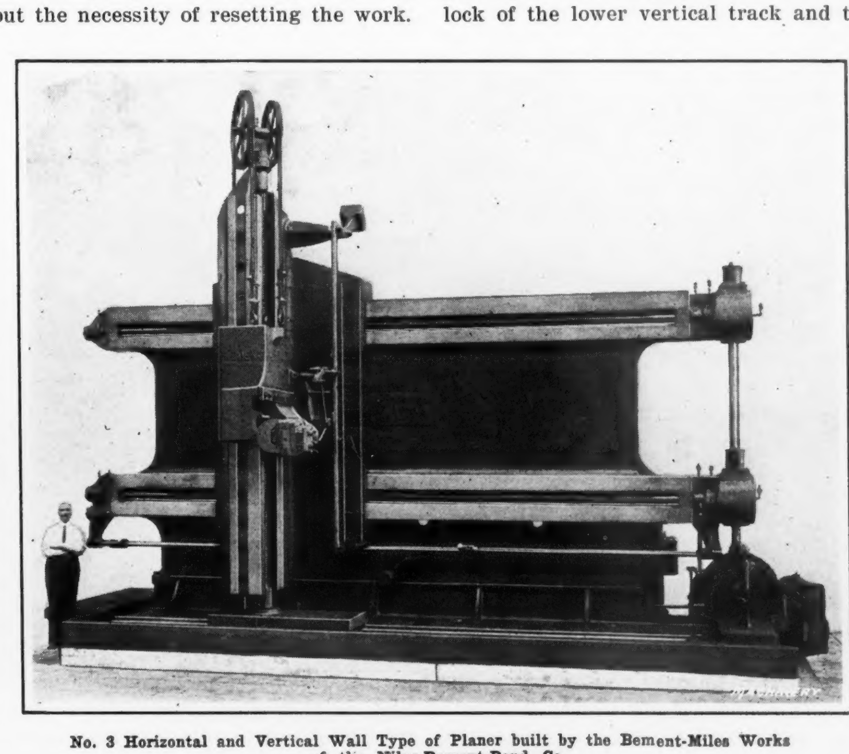
Bement Horizontal and Vertical Wall Planer

This combination vertical and horizontal planer consists of a wall plate on which a vertical rail is mounted. For horizontal planing, two screws that are mounted on the wall plate are connected with the reversing motor drive, to reciprocate the rail on its horizontal bearings; and at the same time, a screw in the rail is connected with the feed mechanism, in order to impart a feed motion to the tool-saddle. For vertical planing, this method of making connection with the driving motor and feed mechanism is reversed, so that the two horizontal screws feed the rail along the bed, and the reversing motor reciprocates the tool-saddle up and down upon the rail.

A No. 3 horizontal and vertical wall type of planer has recently been added to the line of machine tools built by the Bement-Miles Works of the Niles-Bement-Pond Co., 111 Broadway, New York City. This machine is intended for use in finishing the surfaces of large castings which are of such bulk and weight that they cannot be machined on an ordinary planer. The provision for working on both horizontal and vertical surfaces makes this new planer especially adapted for the performance of operations on castings where it is required to plane both horizontal and vertical faces of the work and have them at exact right angles. This result can be accomplished, because all of the planing is done without the necessity of resetting the work.

Another application of this machine is for facing the ends of long castings which would not pass between the housings of a planer of standard design. The machine has sufficient capacity to plane 15 feet horizontally and 8 feet vertically, but a greater planing capacity could, of course, be provided in either direction.

Reference to the illustration will show that this planer consists of a wall plate which is supported by three posts that are of a liberally proportioned box section to assure the maintaining of accurate alignment when the machine is taking a heavy cut. On the wall plate there are bearings which support a vertical rail that has a horizontal movement. The wall plate forms three horizontal rails, one on its top surface which carries the weight of the rail, and two on its vertical face to serve as guides. The vertical rail is made of a heavy box section with reinforcements at the rear. This method of construction, acting in conjunction with extensions at the front of the rail, provides exceptionally long bearing surfaces that afford adequate support for the cross-rail and tool-saddle when the machine is planing in any direction. The rail is gibbed to the square lock of the lower vertical track and to the rear of the top bearing surface on the wall plate, with means for easily taking up lost motion resulting from wear. It will be seen that the tool-saddle has a long bearing on the rail.



No. 3 Horizontal and Vertical Wall Type of Planer built by the Bement-Miles Works of the Niles-Bement-Pond Co.

When the machine is used for planing horizontally, a vertical feed movement is imparted to the saddle on the rail; and when planing vertically, the rail has a horizontal feed movement on the wall plate. In each of the tracks on the vertical surface of the wall plate, there is an accurately cut steel screw, these screws

being geared together by a vertical shaft. Owing to the fact that the two screws bear the same relation to each other, the rail is traversed horizontally, and always maintains an accurate vertical position. A screw mounted in the rail imparts vertical movement to the tool-saddle. By means of suitably arranged clutches, the horizontal screws may be connected with the driving motor for horizontal planing; and when this is done, the vertical screw is engaged with the feed mechanism for feeding the tool-saddle vertically along the rail. A similar arrangement of clutches provides for engaging the vertical screw with the driving motor; and when this is done, the two horizontal screws are connected with the feed mechanism to provide for feeding the vertical rail horizontally along the wall plate. There is a tool-rest on the saddle which has a compound swiveled slide and an apron with spring relief. The whole tool-slide is made to turn around its center for presenting the tool apron in the right direction, for either horizontal or vertical planing. An in-and-out traverse movement of 25 inches is provided for the tool-slide, and this may be operated by hand or by an automatic feed. The saddle is counterbalanced by means of steel cables running up over sheave wheels at the top of the rail and connected with a counterweight which moves inside the rail.

Power for driving this machine is furnished by a 30-horse-power direct-current reversing electric motor which is wound for 220 volts, and has a speed range of 1 to 4. By means of the motor range, the cutting speeds may be varied from 1 to 2 and the return speed is also variable, this return movement being made at twice the cutting speed. The motor is directly connected by gearing, and it is provided with a Pond patented controller with no-voltage and overload release, by means of which any cutting speed may be obtained combined with any return speed within the range that is available on this machine. The cutting speeds are from 14 to 25 feet per minute in either direction, and the return speeds are from 25 to 50 feet per minute. For feeding the vertical rail along its horizontal tracks or for feeding the saddle along the rail, the range of feed movements provided by means of a ratchet mechanism are from 1/50 to 1/2 inch; and the tool-slide has an in-and-out feed movement ranging from 1/32 to 1/4 inch. These feeds are arranged so that they can be thrown into gear in only one direction at a time. The motions of the saddle and vertical rail are automatically reversed at any predetermined position or for any required length of stroke, by means of adjustable stops carried on the vertical and horizontal shifter rods. A ladder is attached to the vertical rail for the convenience of the operator in adjusting the dogs on the vertical shifter rod, when it is in a position out of reach from the floor. There is also a platform for the workman, which slides along a planed track on the bed of the machine, this platform being connected to the lower end of the rail and traversed with it. A floor plate with T-slots in its upper surface is usually furnished with the machine, this plate being securely bolted to the bed. It is used for supporting and fastening the pieces of work to be planed. Such a floor plate is not shown on the machine that is illustrated.

CINCINNATI HIGH-POWER VERTICAL MILLING MACHINE

This high-power vertical milling machine has been developed along the same general lines as the Cincinnati No. 5 horizontal miller shown in the June number of MACHINERY. *It embodies many of the same features of design, such as an automatically controlled intermittent feed movement with rapid power traverse of the table between feed movements, a brake which automatically stops the spindle when the driving clutch has been disengaged, and adequate provision for lubricating the mechanism and delivering coolant to the work.*

A No. 4 high-power vertical-spindle milling machine has been developed by the Cincinnati Milling Machine Co., Cincinnati, Ohio, which is designed along the same lines and incorporates many of the same features that are present on the No. 5 high-power horizontal-spindle milling machine built by the same concern, which was illustrated and described in the June number of MACHINERY. A view of the left side of the machine is shown in Fig. 1, while the right side of the machine is illustrated in Fig. 2. This machine is adapted for certain classes of die and tool work and many manufacturing operations, where a vertical miller has obvious advantages over a horizontal milling machine; the method of holding the work is often simpler and the work is more accessible and easier to be observed. Also in combination with a rotary milling attachment shown in Fig. 1, the vertical type of machine may be used for continuous milling operations.

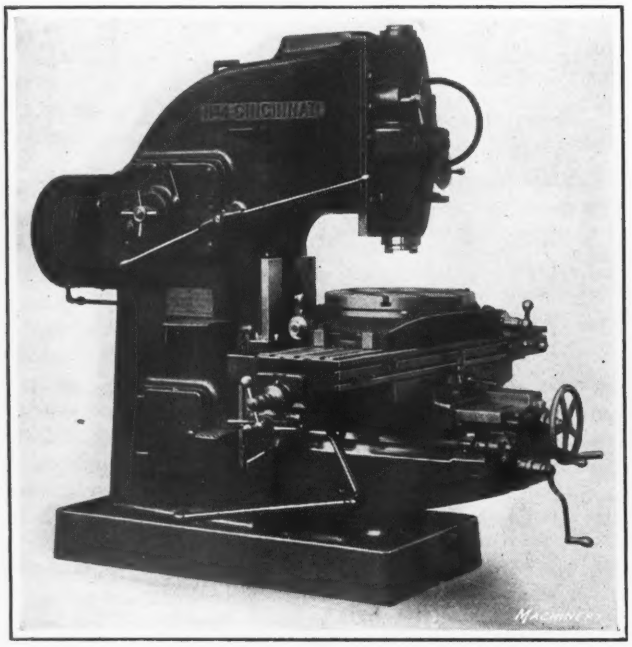


Fig. 1. No. 4 Cincinnati High-power Vertical Milling Machine with Circular Milling Attachment

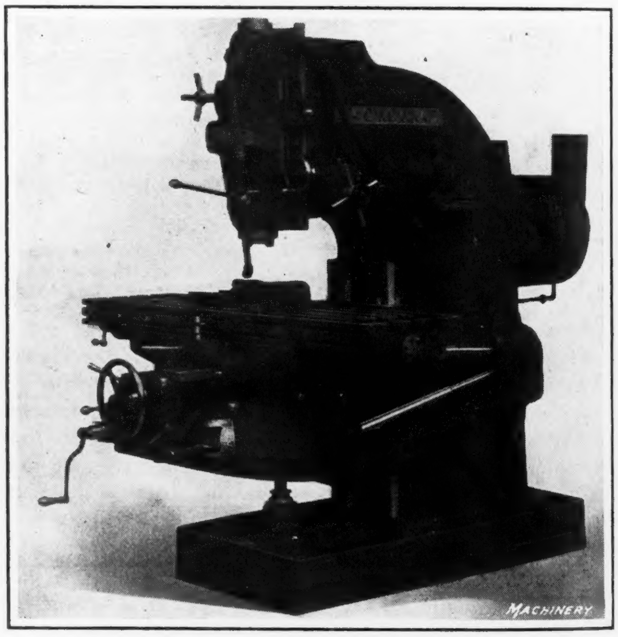


Fig. 2. Right-hand View of Same Machine shown in Fig. 1, without Circular Milling Attachment

General Design of the Machine

The column of this machine has been made adequately strong to take care of the strains which are produced by the cutter in a machine of this type when taking heavy cuts at high rates of speed. The knee has also been liberally proportioned in order to absorb these strains and also to support the table, saddle, fixtures, and work. Square-gibbed bear-

ings with narrow guides are provided for holding the knee to the column and for holding the saddle to the knee. The method of square gibbing allows the incorporation of a clamp for securing the saddle in position on the knee, which is so effective that no special stops or other facilities are required when heavy irregular cuts are being taken. Fig. 1 shows the machine provided with a circular milling attachment for continuous milling, which at the same time allows the table feed to be used independently of the rotary feed, and the power quick traverse to be used for both the machine table movement and for rotating the circular attachment. The table is of the box type of construction and is well ribbed.

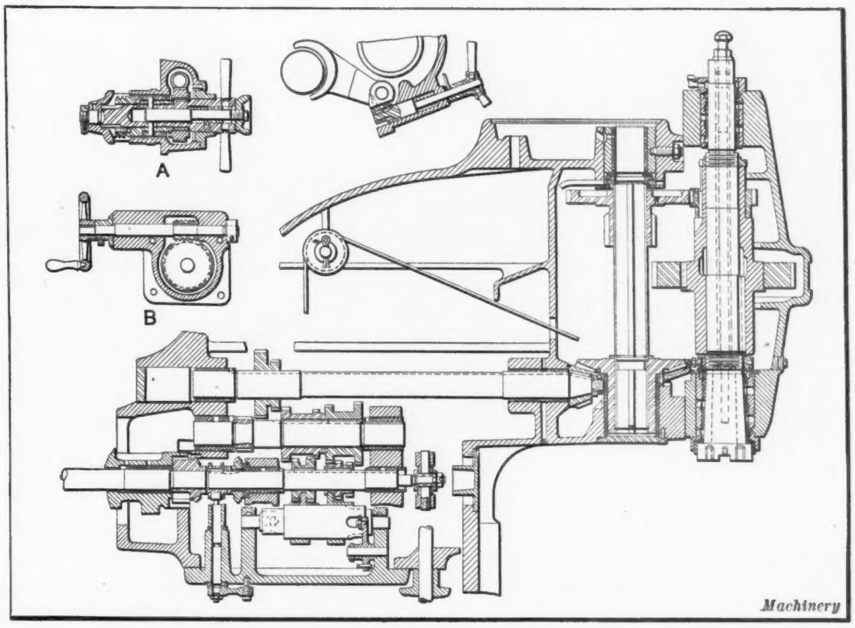


Fig. 3. Sectional View showing Arrangement of Speed-changing Mechanism

The machine is driven by a pulley which is mounted on a bracket fastened to the rear of the column. The pulley runs on ball bearings and drives the machine by means of a friction clutch which may be operated by the starting lever from either the front or rear of the machine. A brake is connected to the starting lever which automatically stops the spindle after the clutch has been disengaged. The pulley is enclosed by the guard. The driving shaft of the machine runs at a fast speed which allows the use of a high-speed motor.

Arrangement of the Speed-changing Mechanism

A sectional view of the upper part of the machine which clearly illustrates the speed-changing mechanism is shown in Fig. 3. This mechanism is similar to that of the No. 5 machine except that the spindle and back-gear shafts are placed in a vertical position. It will be noted that the back-gear shaft is driven by means of a pair of bevel gears which are driven through a train of sliding change-gears and a clutch mechanism from the driving shaft. The pilot wheel and lever which are used to place the proper gears in mesh for any required speed may be seen in Fig. 1. The back-gear shaft has four integral keys (see Fig. 3) on which the back-gears slide, which eliminates the necessity of the spindle sliding through any gears. The gears on the back-gear shaft may be selectively brought into mesh with the gears that are mounted on a sleeve which is secured to the spindle, and when the spindle head is adjusted vertically the gears on the back-gear shaft slide along with the head and retain the proper driving engagement. The lower end of the sleeve is slightly tapered and is keyed on the spindle, this construction placing all the driving strains upon the sleeve. A view of the back-gear shaft is shown in Fig. 4 in which the spindle head has been removed from the machine.

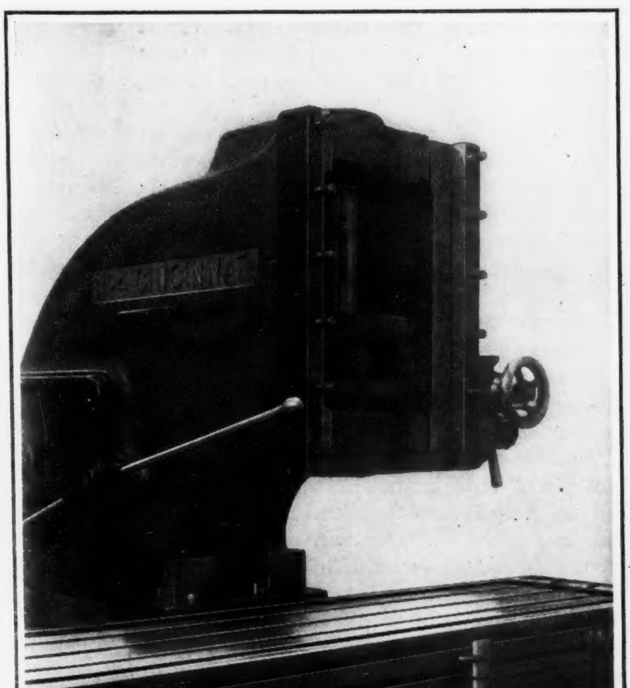


Fig. 4. Arrangement of the Back-gear Shaft, with Spindle Head removed

Spindle Head Adjustment and Feeding Mechanism

A rear view of the spindle head unit disassembled from the machine is shown in Fig. 5. This spindle head is square-gibbed to the column and has a maximum vertical adjustment of six inches by means of a pilot wheel which turns a pinion, the teeth of which engage a rack on the spindle head. The pilot wheel may be seen at the right side of the column in Fig. 2, one complete revolution of the wheel moving the head the full adjustment. A close adjustment of the head is also provided by means of a handwheel that is located above the pilot wheel and at right angles to it, which engages a worm and worm-wheel with the spindle head adjusting shaft. The worm and worm-wheel are brought into engagement by means of a fine-tooth clutch which is operated by

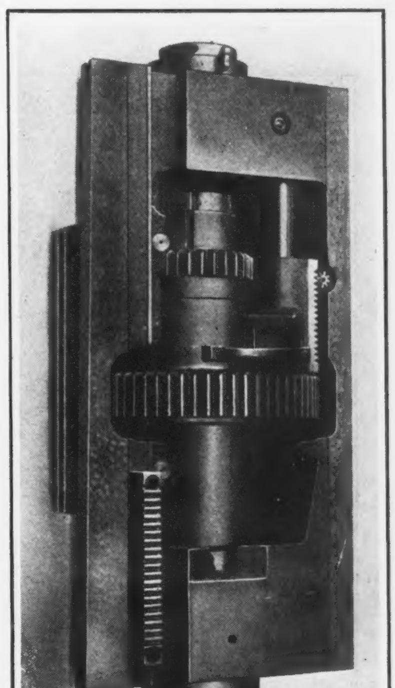


Fig. 5. Spindle Head Unit disassembled from the Machine

a knob in front of the pilot wheel. Sectional views of the mechanism used for adjusting the spindle head are shown at *A* and *B* in Fig. 3. A micrometer stop and dial are provided for accurate adjustment.

The feed mechanism is placed on the right side of the knee, being similar to the one that was provided on the No. 5 machine; and as the feed changes are obtained in the same manner, a further discussion of these features is unnecessary. Likewise, the intermittent feed and power rapid traverse that featured the No. 5 machine are also furnished on this machine.

Oiling Provision and Principal Dimensions

The same lubricating arrangements that were supplied on the No. 5 horizontal milling machine are furnished with this vertical miller. The principal dimensions of the vertical machine are as follows: Size of table, 19 by 68 inches; diameter of driving pulley, 16 inches; width of belt, 5 inches; rapid traverse for cross and vertical adjustment, 30 inches per minute; rapid traverse of table feed, 100 inches per minute; capacity of centrifugal lubricant pump, 11 gallons per minute; and weight approximately 9500 pounds.

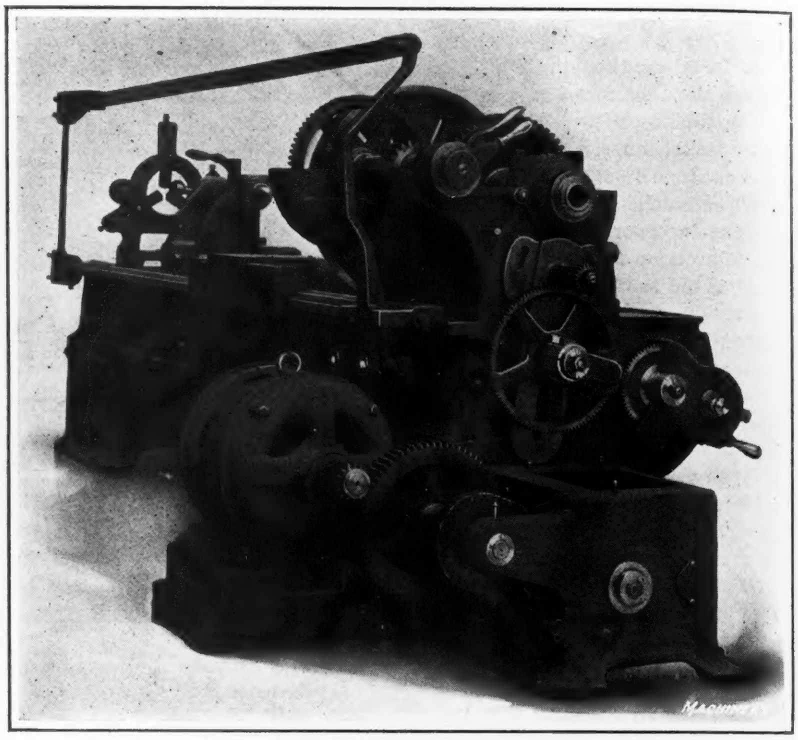


Fig. 2. Bradford Geared-head Lathe equipped with Individual Electric Motor Drive

BRADFORD GEARED-HEAD LATHES

The Bradford Machine Tool Co., Eighth and Evans Sts., Cincinnati, Ohio, is now building a line of geared-head lathes in sizes ranging from 14 to 32 inches, inclusive. These machines may be equipped with either an individual electric motor drive or a single-pulley drive, according to the requirements of the purchaser. It will be apparent to those who are familiar with the cone pulley driven lathes of this company's manufacture, that the design of the new machine is essentially the same, with the exception of the driving arrangement. The dimensions of the cone-head or geared-head lathes are also the same, except that the available distance between centers is usually greater for machines with the geared head.

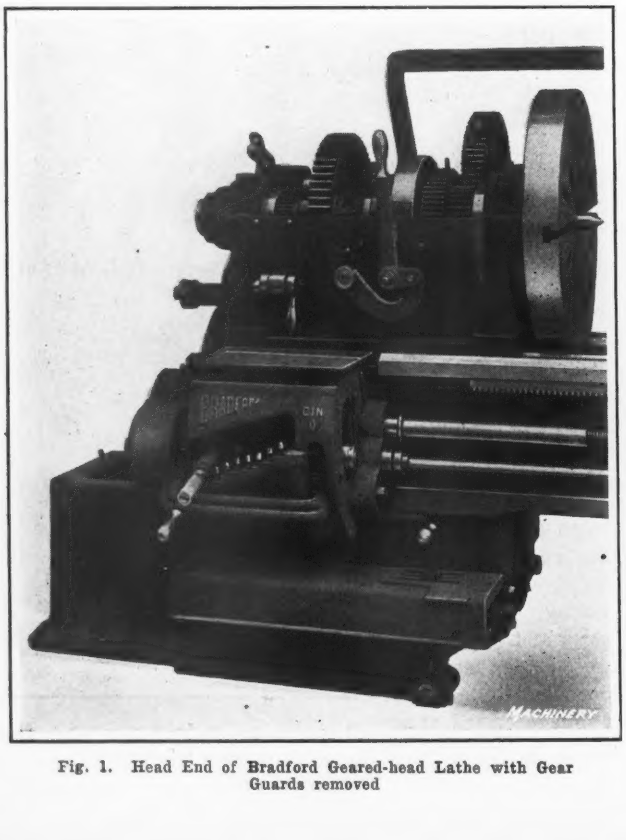


Fig. 1. Head End of Bradford Geared-head Lathe with Gear Guards removed

A feature of the new type of Bradford lathe equipped with an individual motor drive is the low mounting of the motor. The driving mechanism is placed beneath the bed and operates through a selective-speed gear-box which transmits power up to the spindle. Attention is called to the fact that the single-pulley drive for lathes of this type is interchangeable with the motor drive, and is similarly featured by the low mounting of the driving pulley. A machine so equipped requires only a single fixed pulley on the lineshaft, or a suitably located short shaft which is driven from the lineshaft, it being unnecessary to use a friction clutch operated countershaft. A selective-speed gear-box similar to that used with motor-driven lathes, is employed in the case of machines equipped with single-pulley drives. These machines can be installed with either independent or group motor drive. In cases where a group drive is employed, a single motor-driven overhead shaft is used to carry the driving pulleys.

Regardless of whether these lathes are equipped with an individual motor drive or a single-pulley drive, the means furnished for the transmission of power is essentially the same. It consists of an arrangement of driving shafts and gears, as illustrated in Fig. 3. Six gears on shaft *A* afford six independent driving speeds for shaft *B*, which through intermediate shafts *C* and *D*, and the connecting chain *E* drives the lathe spindle. The drive is direct when clutch *F* engages gear *G* or power is transmitted through a back-gear shaft *H* when the positive clutch *I* engages gear *J*. Twelve spindle speeds are thus obtained, and corresponding reverse spindle speeds are obtained when the lower clutch *K* engages the chain drive *L*, automatically disengaging the clutch and driving gear *M* used for the forward drive. The operating arrangement on this machine includes an ordinary pole and speed-box lever that are in such operative connection with each other that gear shifts in the speed-box cannot be made unless the initial driving power clutch is moved by the shifter pole to its central, or disengaged, position. By this arrangement, which is effective through an interlocking device, no abuse of mating gears in the speed-box is possible because they can only be engaged after the driving power is disengaged by the shifter pole.

Mechanical speeds through the speed-box are selective and instantly obtained by sequential movements of the shifter pole and speed-box lever. Provision is made for starting, stopping, or reversing the lathe by means of the shifter pole.

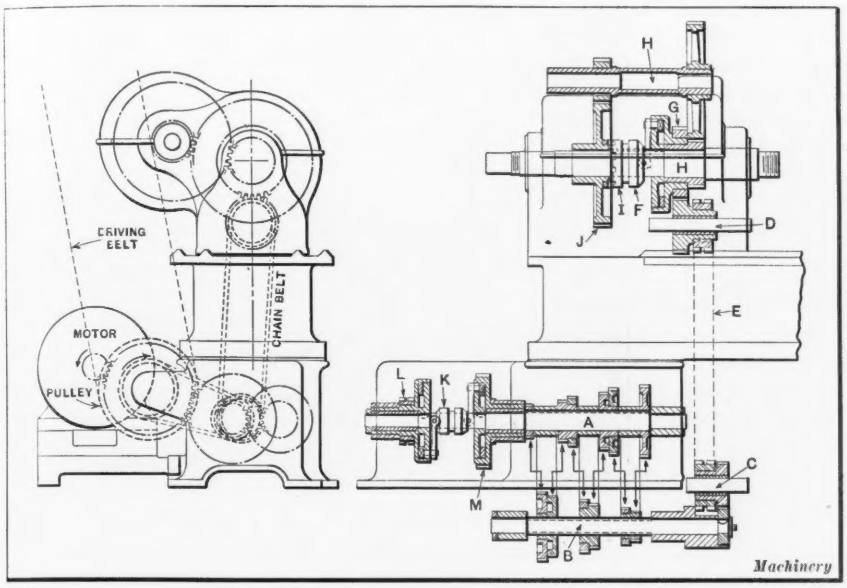


Fig. 3. Arrangement of Driving Mechanism on the Bradford Geared-head Lathes

which runs the full length of the machine, as in the case of Bradford lathes of the cone pulley type. A constant-speed drive is employed on these machines, either by means of a motor or single pulley, as required. Starting, stopping, and brake-stopping of this lathe is effected through simple mechanical means. The back-gear lever on the head also serves to quickly start and stop the lathe, the latter function being facilitated by a mechanical friction brake that automatically applies itself directly to the revolving work-spindle when in the disengaged position. Quick stopping of the revolution of the work is thus effected at all times and at all speeds whenever the back-gear lever is placed in its neutral or braking position. In the two end positions, the high and low driving speeds for the lathe spindle are obtained. For all work done close to the headstock, the use of this lever on the head is usually preferred for starting and stopping, and the shifter pole need not be used except for reversing.

DEFIANCE MULTIPLE-SPINDLE DRILLING MACHINE

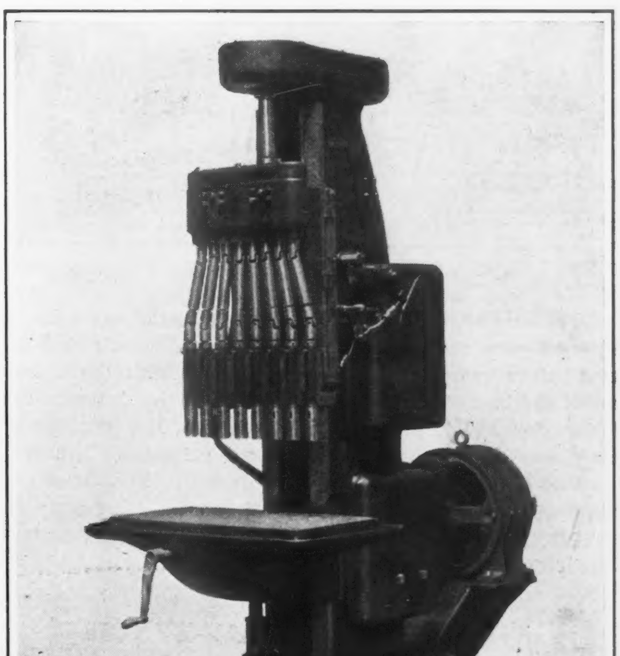
A No. 10 multiple-spindle drilling machine has been produced by the Defiance Machine Works, Defiance, Ohio, which has a capacity for drilling eight 3/4-inch holes. This machine can be equipped with a group of spindles having fixed centers arranged in a straight line or in a cluster, or with a group of universally adjustable spindles arranged in a straight line, or in a rectangular or circular cluster. The speed mechanism is located in the column near the base, the power being transmitted to a vertical driving shaft from a three-step cone pulley by means of back-gears and bevel gears. A friction clutch is used to engage the power and to select the back-gear, and when used in conjunction with the cone pulley, these back-gears permit six speed changes. The spindles are driven by means of a sleeve gear which is mounted on the vertical driving shaft. This sleeve gear slides along the driving shaft with the spindle head as the head moves up or down, this construction providing a drive which is always closely coupled to the spindle head. Back-gears are not furnished when the machine is driven by a direct-connected variable-speed motor.

The feed mechanism is driven from the driving shaft by means of bevel gears, and is also housed in the column above the speed mechanism. It consists of two friction clutches and a jaw clutch. By engaging one of the friction clutches, the spindles are rapidly advanced until the drills come in contact with the work, at which point the jaw clutch is automatically engaged to feed the drills. When the cut has been completed, the other friction clutch is automatically engaged to effect a quick return of the spindles to the starting position. The feed-screw is operated by the feed mechanism through a vertical driving shaft and a train of spur gears, threads on the screw being engaged by a bronze nut. As this screw is located directly above the work, a vertical feed thrust in central alignment with the spindle is obtained; the end thrusts on this screw are taken by S K F ball bearings. The spindle head which supports the spindles and contains the spindle driving gears, is a casting of box construction and is gibbed to the column.

When the spindles are arranged to be adjusted either universally or in a straight line, they are individually connected to the driving gears by telescopic driving shafts fitted with universal joints, but when the spindles are arranged with fixed centers, they are connected to the driving gears without universal joints. The universally adjustable spindles are supported by brackets which are fastened to a cross-rail. Ball bearings take the thrusts of all the spindles.

Either a knee or a box type of table can be furnished. The knee type is gibbed to the column and is vertically adjustable, the adjustments being obtained by a crank-lever, which through a spiral gear mechanism actuates a jack-screw. The box type of table is provided with T-slots to which the work may be clamped. The bottom of this table is secured to a planed surface on the base, which is also provided with T-slots.

The oiling system consists of a forced feed, gravity flow and splash system combined. The speed and feed mechanisms and the spindle head are each provided with independent and self-contained oiling systems, each of these units being encased and partially submerged in oil, while the bearings are lubricated by a forced feed through individual leads. Attachments such as a hand feed for the spindle head, motor drive, work-holding fixtures and tools, and equipment for cutting compounds, including a pump, tank, and pipe fittings, are not included in the regular equipment of

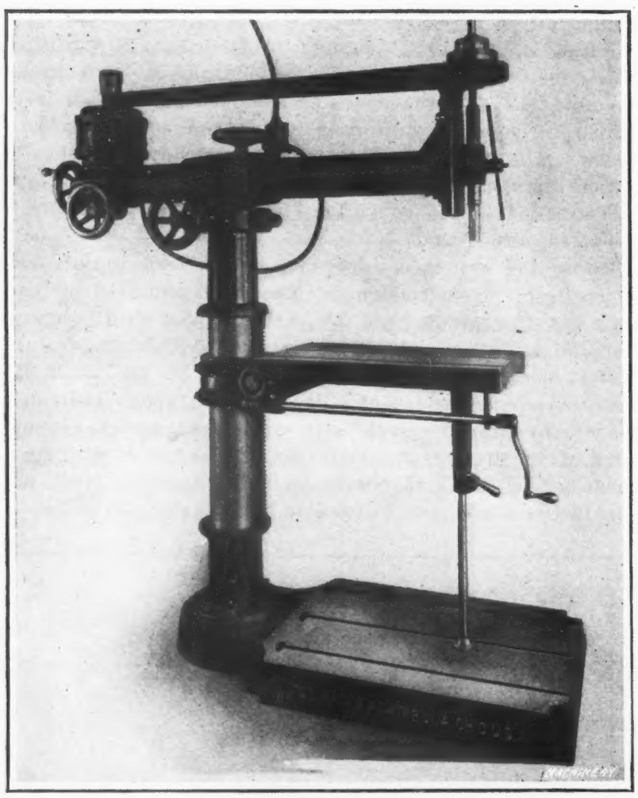


Multiple-spindle Drilling Machine developed by the Defiance Machine Works

this machine, but can be furnished if desired. Some of the main dimensions are as follows: Maximum distance from center to center of spindles, 22 inches; minimum distance, 12 inches; maximum distance from nose of spindle to base, 44 inches; minimum distance, 30 inches; maximum distance from nose of spindle to table, 32 inches; distance from center of spindle to column, 10 inches. The net weight of the belt-driven machine is 5300 pounds and of the motor-driven machine, 6900 pounds.

HAWES SENSITIVE RADIAL DRILLING MACHINE

A sensitive radial drilling machine having a capacity for drilling holes up to ¾ inch in diameter has recently been placed on the market by C. L. Hawes, 12 Adams St., Ashtabula, Ohio. An unusual feature of this machine is that the spindle is mounted on one end of an arm arranged to slide in a bearing on the top of the main column, which has a locking device for clamping the arm in any position. The advantage of this feature is that the arm does not interfere with the work of the operator. The motor for driving the spindle is mounted on the opposite end of the arm so that

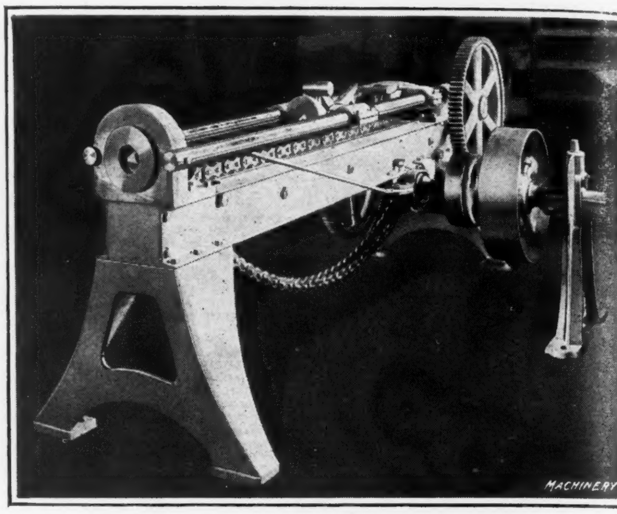


Sensitive Radial Drilling Machine developed by C. L. Hawes

the distance between the pulley centers is the same for the different positions of the arm. The motor is controlled by a push-button switch and is adjustable to permit the tightening of the belt when the belt is placed on the different cone pulley steps. The principal dimensions of the machine are as follows: Maximum distance from column to center of spindle, 40 inches, and minimum distance, 9 inches; maximum distance from base to nose of spindle, 47 inches; size of table, 16 by 29 inches; travel of table, 18 inches; and net weight of machine, 2300 pounds.

WINTERHOFF DRAW-BENCH

A draw-bench has recently been placed on the market by the Winterhoff Tool & Machine Co., Elkhart Ave. and Jackson St., Elkhart, Ind., which possesses some improved features in the design of this class of equipment. This draw-bench is adapted for drawing seamless tubing through dies, using a sizing mandrel to give the required inside diameter



Draw-bench built by the Winterhoff Tool & Machine Co.

of the work, according to the usual practice. In addition, the draw-bench may be used as a broaching machine, it being merely necessary to provide a suitable work-holding device in place of the die-holder, and to afford means of securing the broach in the traveling carriage on the machine. A draw-bench of this type may be built in various sizes with provision for obtaining any required length of stroke for the traveling head. The special feature of the design is that guide rods are furnished for the traveling carriage, these rods being in perfect alignment with each other, and with the required line of travel of the carriage. Otherwise, they would fail to provide the condition of operation for which they are furnished. An automatic and safety stop is provided that disengages the carriage hook from the chain at any desired point, and thus stops further movement of the carriage and work. The operating chain is a standard roller-link type, with a capacity for pulling fifteen tons. It is back-geared with a ratio of approximately 150 to 1.

NATIONAL TOOL-ROOM GRINDER

The National Machine Tool Co., 1825 N. Erie St., Racine, Wis., has developed a tool-room grinder that may be mounted on lathes, shapers, milling machines, or planers in such a manner that the wheel will move over the work. It is suitable for grinding tools, cutters, and gages, and is especially adapted for grinding cutters, arbors, reamers, mandrels, etc., when held between the centers of a lathe. The grinding arbor has a hollow spindle with a collet which holds a 5/16-inch bar on which a wheel up to 4 inches in diameter may be mounted for internal grinding. This method allows the internal grinding wheel to be adjusted. By means of this

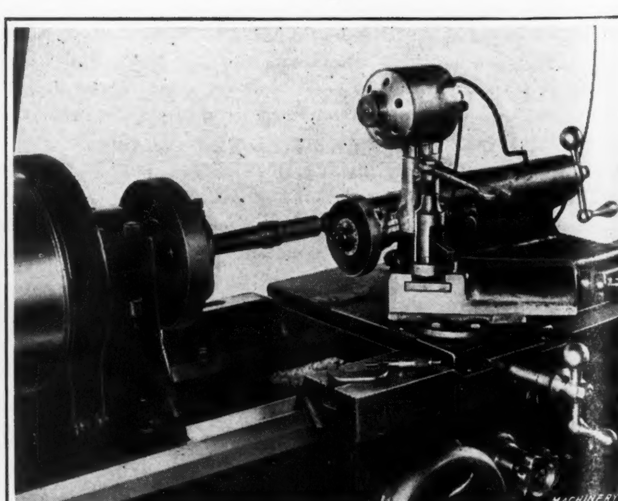


Fig. 1. National Tool-room Grinder performing an External Grinding Operation

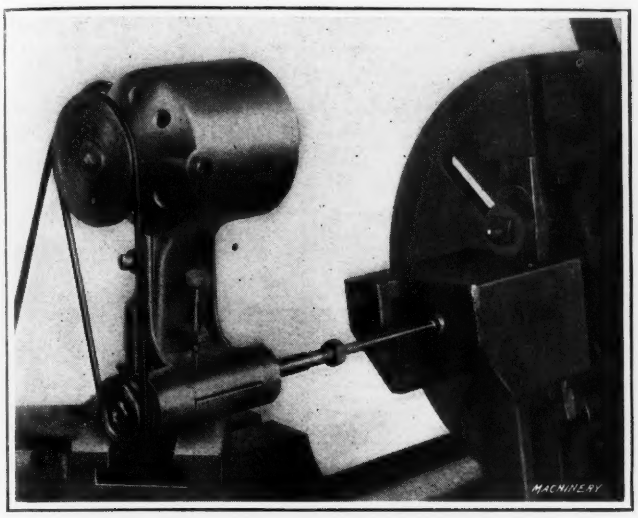


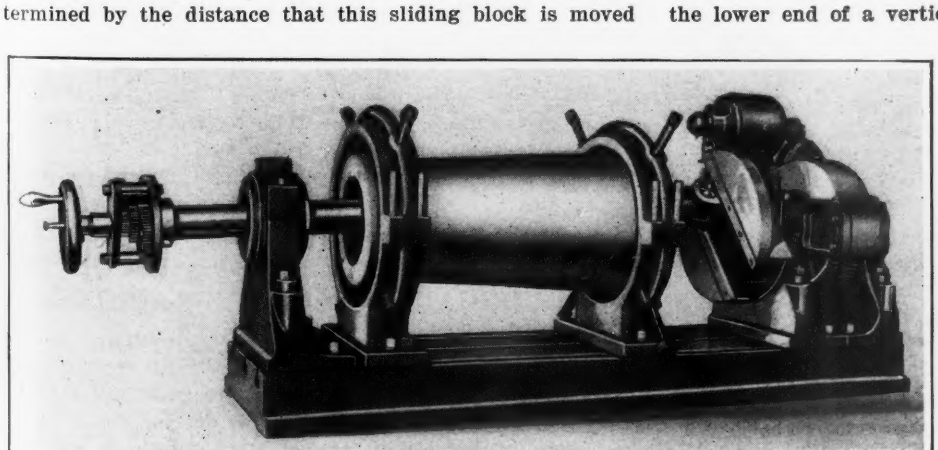
Fig. 2. Same Grinder as shown in Fig. 1 performing an Internal Grinding Operation

collet the grinder can also be used for lapping small dies, bushings, and other work which is performed by lapping machines. In Fig. 1 the grinder is shown mounted on the toolpost of a lathe for an external grinding operation, and Fig. 2 shows the grinder being used for performing an internal grinding operation.

The motor is placed above the spindle in such a manner that it causes no interference with parts of the machine to which the grinder is attached, and the grinding wheel is so mounted that it can be used down to the washer. It is claimed that the armature is balanced by a patented device in such a manner that the motor does not become overheated even if run constantly. It is wound to be connected to a 110- or 220-volt direct- or alternating-current circuit and gives a speed of 12,000 revolutions per minute. By using a smaller pulley on the motor, this speed may be reduced to 6500 revolutions per minute, and by using a larger pulley on the motor, the speed may be increased to 22,000 revolutions per minute. The changing of pulleys is a simple matter because the center distance between the two pulleys is adjustable. A cotton belt is used to drive the grinder.

PEDRICK TAPER BORING MACHINE

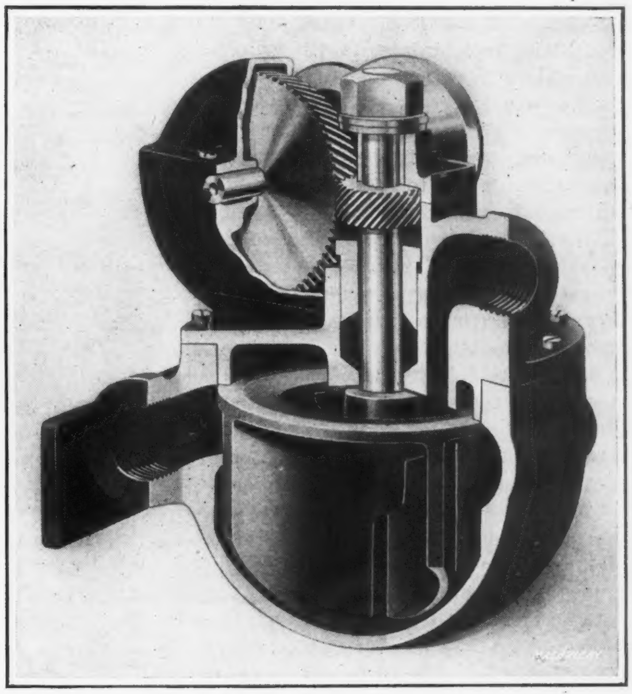
A horizontal taper hole boring machine, which is suitable for boring any taper that is ordinarily used in machine work, has been designed and built by the Pedrick Tool & Machine Co., 3639 N. Lawrence St., Philadelphia, Pa., and is here illustrated and described. The machine is simply and rigidly constructed. The boring-bar and driving mechanism are supported by three pedestals which are mounted on a bedplate. The boring-bar is connected to a sliding block on the faceplate by means of a strongly constructed hinge joint. The degree of taper to which the work is to be bored is determined by the distance that this sliding block is moved away from the center of the faceplate; thus it is obvious that when the sliding block is located in the center of the faceplate, the machine is adapted for straight boring operations. The boring-bar is supported in a pedestal at the rear end of the bed by a bearing which has been designed to permit the necessary oscillation or orbital movement of the boring-bar. The feed-screw which traverses the cutter-head along the boring-bar is imbedded in a groove in the boring-bar. The feeding mechanism, located at the rear end of the boring-bar, controls this feed-screw by means of a constant automatic movement which is changeable to permit the taking of roughing and finishing cuts. The work is supported on two steadyrests which are also mounted on the bedplate. The bedplate is 28 inches wide by 96 inches long; and the boring-bar is 3 inches in diameter. The cylinder which is shown mounted on the machine was bored a distance of 30 inches, the bore being 12 inches in diameter at one end and 9 inches in diameter at the other end. The machine may be equipped for either belt or motor drive.



Taper Boring Machine developed by the Pedrick Tool & Machine Co.

"VOLYUM" COOLANT PUMP

For use in delivering coolant to the cutting tools and work on machine tools, the Volyum Pump Co., 419 W. Liberty St., Cincinnati, Ohio, has developed a vertical-shaft centrifugal pump which can be readily attached to any machine tool. The impeller, which is of the open type, is mounted at the lower end of a vertical driving shaft, and extends the full length of the hemispherical body. There is no contact between the impeller and the body casting. Two long bearings support the impeller shaft, both of which are located above the water-line, one being formed by the stuffing-box gland above the impeller, while the other bearing is located in the cap. Power is transmitted through two right-angle spiral gears which step up the speed in the ratio of 3 to 1. The large gear, which is mounted on the driving shaft, runs in oil. Both shafts and the front bearing are well lubricated by the constant circulation of oil.



Sectional View of the Coolant Pump made by the Volyum Pump Co.

Driving is usually accomplished by a belt running over a three-inch flanged pulley, although a gear or sprocket wheel could be substituted for the pulley. This pump can be mounted on either side or end of a machine, the various angles of drive being obtained by swiveling the cover in relation to the body of the pump and placing the pulley on either side of the cap. By locating the suction pipe above the supply pipe, any tendency toward loss of prime is eliminated, because when the pump is brought to a stop, it retains a body full of liquid. This pump is made for a 3/4-inch pipe connection, and tests made at various heads from 4 to 12 feet, suction lifts from 18 to 26 inches, and pulley speeds from 400 to 750 revolutions per minute showed a pumping capacity ranging from 5 to 22 gallons per minute.

CHAPIN & BAKER TOOL-HOLDERS

The Chapin & Baker Mfg. Co., Inc., 143 Edison St., Syracuse, N. Y., is now manufacturing the tool-holders which form the subject of the following description. One of these is intended for use in roughing out the teeth of bevel gear blanks, while the other is adapted for the performance of turning operations on lathe work, and for similar classes of service. Referring first to the illustration of the gear-cutting tool shown in Fig. 1, it will be seen that a formed cutting tool *A*, which is made of high-speed steel, is carried by a nickel steel shank *B*. Three holes *C* are drilled through the cutting tool in order that the position of bolt *D*, which secures this tool in the shank, may be changed to provide for using up practically all of the high-speed steel in the cutter. Attention is also called to the fact that the cutting tool is formed at both edges, so that it may be turned both edgewise and endwise in the holder, to provide for bringing new cutting edges into the operating position. With such an arrangement, a maximum economy is effected when using high-priced tool steel. After the bolt *D* has been passed through either of the holes *C*, the final clamping of the cutter in its holder is accomplished by tightening a headless set-screw *E*. This set-screw engages the rear edge of the cutter, and by applying pressure holds it firmly in place. Adjustment is provided by means of a headless set-screw *F*. Both screws *E* and *F* are hardened, in order that they may withstand a heavy pressure without tendency to wear or for the screws to become flattened at the end.

Fig. 2 shows a turning tool-holder which is of essentially the same design as the tool shown in Fig. 1. As in the preceding case, the cutting tool *A* is made of high-speed steel and is formed so that either edge may be used for cutting. There are three holes *B*, into any of which screw *C* may enter, so that provision is made for changing the position of the high-speed steel bit as its size becomes reduced through sharpening. The shank of the tool-holder is made from chrome-vanadium steel, and it will be seen that screw *D*, which clamps the cutter in its holder, enters a hole *E* that is drilled and tapped at the end of the holder. Screw *D* fits this tapped hole, but is not of sufficient length to project all of the way through. This screw bears against the end of a plug *F*, which is a sliding fit in the hole drilled through the holder, and pressure applied by screw *D* is transmitted through plug *F* against the inner edge of the cutter. A similar method is employed for transmitting the pressure applied by screw *E* of the tool shown in Fig. 1, through a plug that bears against the inner edge of the high-speed steel bit.

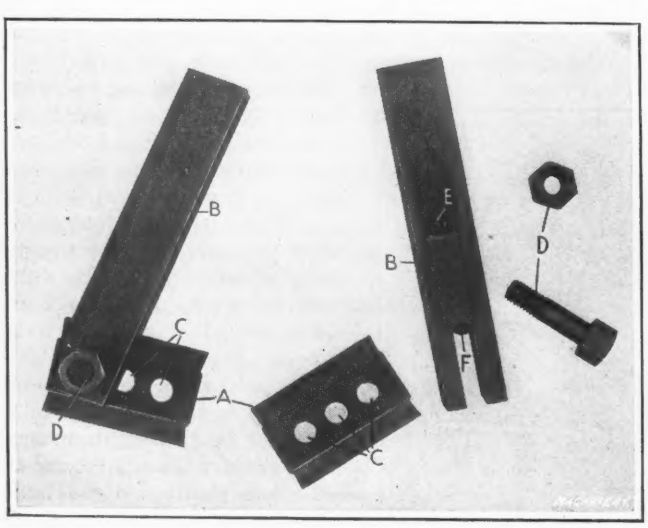


Fig. 1. Chapin & Baker Tool-holder for roughing out Bevel Gear Teeth

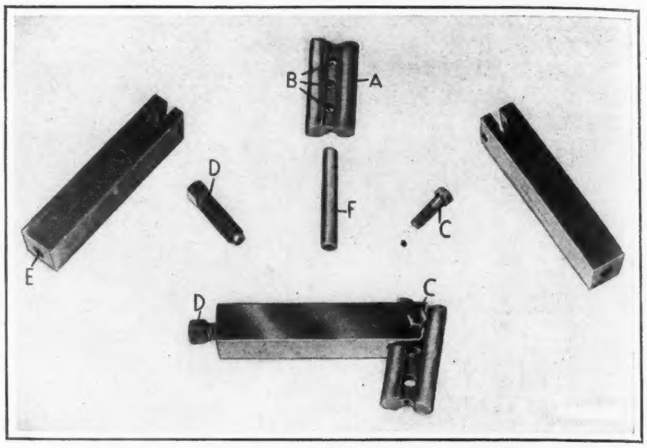
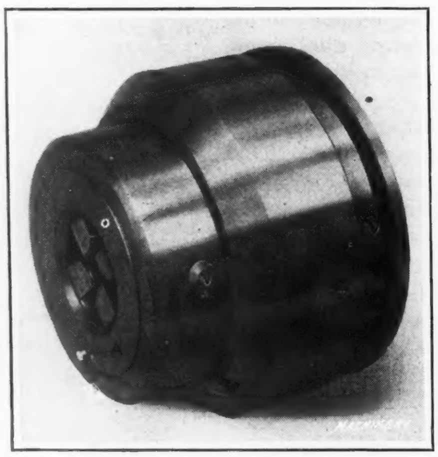


Fig. 2. Chapin & Baker Turning Tool-holder

HARTNESS AUTOMATIC DIE

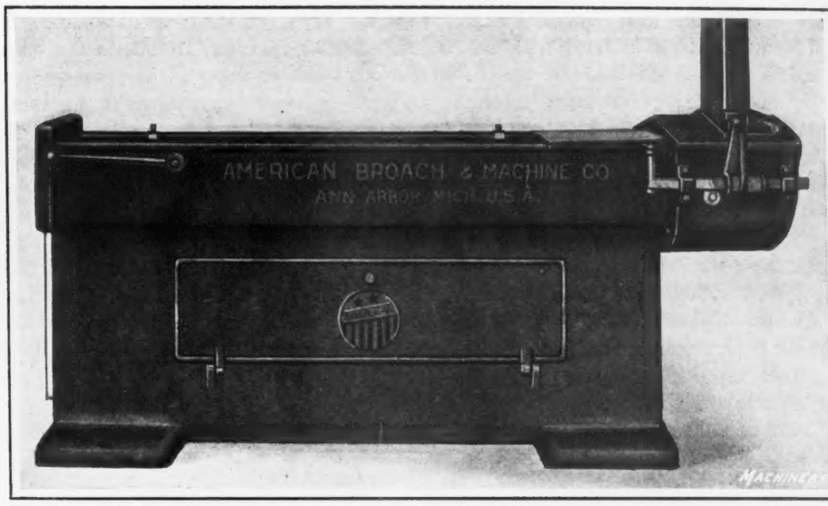


No. 4 Type R Hartness Automatic Die made by the Jones & Lamson Machine Co.

The accompanying illustration shows the new No. 4 Type R Hartness automatic die made by the Jones & Lamson Machine Co., Springfield, Vt., for use on automatic and bolt-cutting machines where the tools revolve. This device may be mounted on either horizontal or vertical spindles. It is relocked by a sleeve which may be operated by a yoke or by engaging a fixed stop on the return movement. The diameter of the sleeve is 6 3/8 inches and the length of the die 5 3/16 inches. It is unlocked in the usual manner by retarding its forward motion, or by the external tripping button *A* coming into contact with a fixed stop, this being especially advantageous for cutting very short threads. This die is suitable for cutting either right- or left-hand threads on work from 1/4 to 1 1/4 inch in diameter. No tools of any kind are necessary in changing the chasers, and the same chasers are used as in the older types of dies having the same capacity and which have been manufactured by this concern. These dies are supplied with shanks to meet the requirements of the customer.

AMERICAN BROACHING MACHINE

The No. 1½ broaching machine shown in an illustration that accompanies the following description has recently been put on the market by the American Broach & Machine Co., Ann Arbor, Mich. In working out the design, this machine has been furnished with an operating handle of the ball control type, which affords a convenient means of operation from any position, as the handle can be located horizontally,



No. 1½ Broaching Machine built by the American Broach & Machine Co.

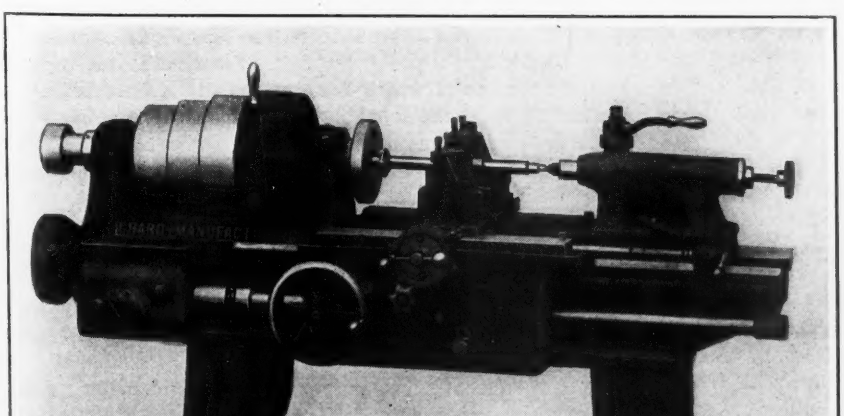
vertically, or at any desired angle around a complete circle. Power is transmitted to the machine through a steel pinion and two idler gears, the main driving gear being of the internal type, which is claimed to give a balanced effect and a more uniform distribution of the load over the gear teeth. All of the gears are enclosed, and they do not run while the machine is making its reverse stroke at high speed. The nut on the operating screw can be quickly taken off without removing the screw, and such removal of the nut can be accomplished regardless of where the screw is located. This nut and a large roller thrust bearing are located in an oil-tight compartment so that they may operate in a bath of lubricant. At the front of the machine there is a finished face with two T-slots for bolting in place the necessary fixtures or supporting tables. An oil-pump which is directly driven from the countershaft furnishes a constant supply of lubricant. The bed is so designed that it not only furnishes ample strength but also allows automatic stops to be placed inside the bed; and a tool cupboard in the base affords a convenient storage space for broaches and other accessories. This cupboard is provided with shelves and so arranged that when the door is open it rests in a horizontal position, providing an additional shelf. The inside of the cupboard door has two hard wood sills across it, so that tools can be laid down without damaging their cutting edges.

The spindle is made of hardened steel and finished to size by grinding. By making the spindle hollow, the operating screw is allowed to pass through it, and the spindle drives the nut which is secured at the front end of the spindle. The gearing is mounted centrally around the spindle. A solid steel sliding head is provided on the machine, this head being fitted with steel shoes that slide in box-shaped ways having removable caps. The screw has a buttress type of thread that affords ample strength, and it is locked to the sliding head by means of a square key and lock-nut that furnish an easy means of assembling or disassembling. The principal dimensions of this machine are as follows: Diameter of bore in face of machine, 5 inches; size of finished face at front of machine, 13½ inches wide by 12 inches high; size of finished face on column, 7½ inches wide by 18½ inches high; capacity of machine, for cutting keyways up to ¾ inch, and square or splined holes up to 1 inch; number of threads per inch on pulling screw, 4; weight of machine with countershaft, 1975 pounds. Standard equipment furnished with this broaching machine includes 1½-, 2-, and 2½-inch reducing bushings to fit the bore in the face of the machine, and ⅜-, ½-, ⅝- and ¾-inch threaded pull bushings. The pulling head has a stroke suitable for operating broaches up to 50 inches in length. The driving pulley on the machine is 14 inches in diameter by 2½ inches face width, and should be driven at 680 revolutions per minute. The pulling head travels at 90 inches per minute, and the reverse speed is at a ratio of 2 to 1, or 180 inches per minute.

CHARD MANUFACTURING LATHE

For use in performing lathe work that is required in the manufacture of parts for automobiles and similar products, the Chard Lathe Co., New Castle, Ind., has recently developed a 16-inch lathe which is illustrated and described herewith. In working out the design, an effort has been made to avoid as far as possible the loss of time in setting up the work and removing it after the operation has been completed. On production work, it is frequently required to take a cut at high speed and under a heavy feed. This imposes severe strains on the machine, and the design must be worked out to successfully withstand loads of this kind, if the machine is to give satisfactory service. It is stated that on this lathe, provision has been made for driving the best grades of high-speed steel tools to the limit of their cutting capacity.

A friction clutch is provided on the spindle, that engages with the cone pulley, thereby doing away with the necessity of stopping the machine with a countershaft. The same operating lever that manipulates this friction clutch also governs the action of a brake that instantly stops the spindle when the drive is disconnected. The tailstock is provided with a lever movement for placing the work between centers, and this also clamps the tailstock spindle. This is a patented feature that does away with a number of motions and should be the means of substantially increasing production. It will be seen that the machine is furnished with a three-step cone pulley that is driven by a 3½-inch belt, the drive being taken from a two-speed countershaft equipped with Hyatt roller bearings, so that there is a total of six speed changes. The feed-box is belt-driven from



Sixteen-inch Manufacturing Lathe built by the Chard Lathe Co.

the end of the lathe spindle, and furnishes three changes of feed by simply shifting a lever. By transposing one gear on the end of the feed-box shaft, three additional changes may be obtained, making a total of six feeds.

All gearing on this lathe is completely covered to assure the safety of the operator. Automatic stops are furnished with the carriage which may be moved rapidly along the bed by hand. A large micrometer dial is furnished on the cross-feed screw to provide for duplicating diameters on repetition work. In the accompanying illustration the lathe is shown equipped with a front and rear plain rest, heavy-duty tool-blocks, multiple cross-feed stops, and multiple length-feed stops. With this combination, it is possible to produce large quantities of work with accurate duplication of dimensions. If so desired, the machine can be equipped for the performance of screw-cutting operations. It can also be equipped with a double tool-block, compound rest, turret tool-block, taper attachment, draw chuck, and a pump, pan, and piping for delivering coolant to the tools and work.

WORCESTER INTERNAL GRINDING MACHINE

The Worcester Machine Works, Inc., Worcester, Mass., have developed a Type A internal grinding machine which is here described and illustrated. The front of the machine with the automatic box cover removed is shown in Fig. 1, while the rear of the machine is illustrated in Fig. 2. The automatic box contains the reversing mechanism of the table and the speed-changing mechanisms of both the table and the work-head. The two latter mechanisms are controlled by the dials at the right-hand side of the box, the upper dial controlling the table speeds and the lower dial controlling the work-head speeds. Three table speeds and four work-head speeds are obtainable and can be made while the machine is running. The upright lever which is connected to the automatic box mechanism controls the reversing clutch. An adjustment enables the travel of the reversing cam to be equalized. The mechanism in the automatic box is driven by means of a friction clutch mounted in a pulley which is well guarded. This friction clutch is controlled by the upright lever at the right end of the machine.

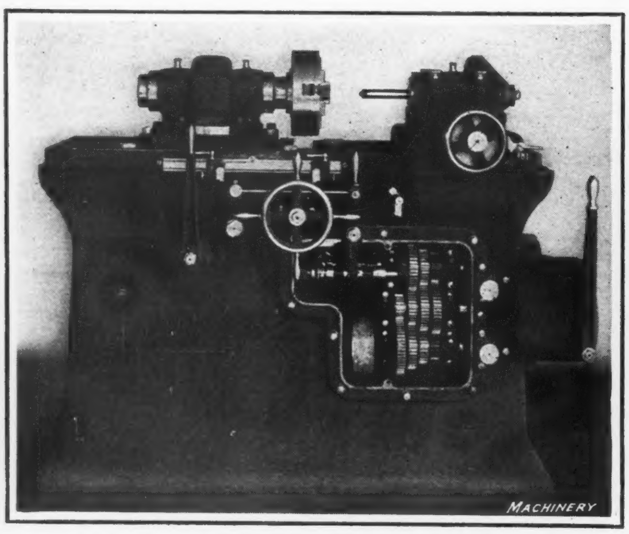


Fig. 1. Type A Internal Grinding Machine built by the Worcester Machine Works, Inc.

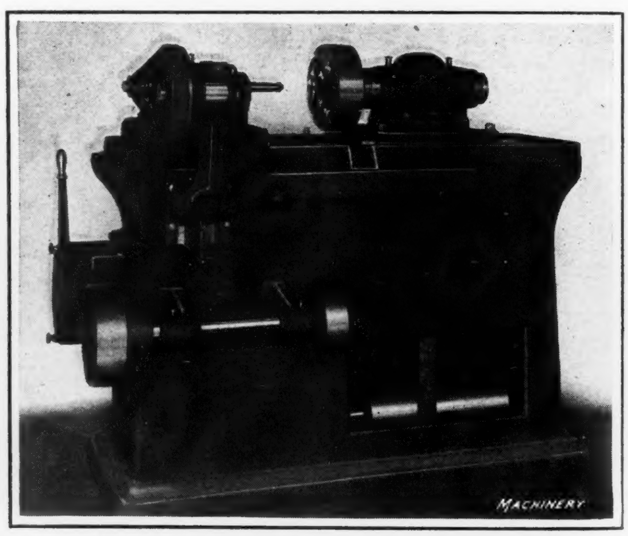


Fig. 2. Rear View of Worcester Internal Grinding Machine shown in Fig. 1

The wheel-head is secured to a cross-slide by means of dovetailed ways and is clamped by gibs and screws. This cross-slide is also secured by means of ways and gibs to a casting which bridges the work-table, this bridge casting being bolted to the base of the machine. It is claimed that by this construction, the vibration caused by the grinding wheel is absorbed by the base. The grinding wheel spindle is driven from an idler pulley which is mounted on a bracket secured to the base on the rear of the machine. The bracket is hinged to a sliding plate and is also connected by a spring link to the cross-slide, thus enabling it to travel freely with the cross-slide. The spring link tends to maintain an even tension on the belt which drives the grinding wheel spindle, regardless of the position of the wheel-head, and the sliding plate compensates for any difference in the length of the vertical driving belt.

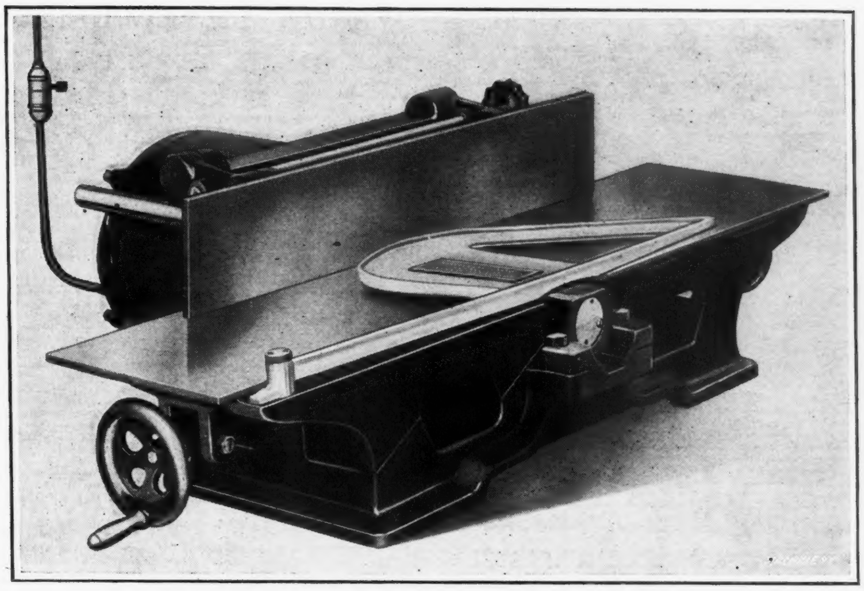
The grinding wheel spindle can be removed readily and one of another size put in place. The wheel-head is so arranged that it can be moved in a crosswise direction without the use of the cross-slide screw, the purpose of this being to permit additional travel of the wheel-head when grinding 20-degree tapers, and to aid the operator when grinding work of two different diameters at one setting of the machine. The work-table is driven by means of a pair of jaw clutches which are controlled by the lever located above the automatic box. This lever enables the operator to quickly disengage the driving mechanism and move the table back for sizing the work. The work-head is mounted on the table and is driven by means of a belt from a drum which is located in the base of the machine. The work-head is arranged to swivel 20 degrees on each side of the center of the table. The drum which drives the work-head is mounted on ball bearings and is located about six inches from the bottom of the base, it being claimed that this location tends to eliminate the transmission of vibration to the work. The drum is driven through the automatic box by means of a belt, the tension of which is automatically maintained. The vertical lever at the left side of the machine is used to lift the drum out of contact with the belt that drives the work-head, thus enabling the operator to move the table to any position when the machine is idle.

Adequate lubrication for the various parts of the machine has been provided, such as an oil-pocket at the extreme right end of the machine from which all of the bearings inside of the base are oiled, oil-cups placed on the work- and wheel-heads, and oil-pockets located in the ways on the base on which the work-table slides. Some of the principal dimensions of the machine are as follows: Swing, 15 inches; depth of work which may be ground, 10 inches; size of table, 51¾ by 15¼ inches; distance from center of chuck to floor, 45 inches; and diameter of hole through spindle, 1¼ inch.

WALLACE BENCH JOINTER

A 6-inch bench jointer which is shown in the accompanying illustration has been developed by J. D. Wallace & Co., 1401-1405 W. Jackson Blvd., Chicago, Ill., for use in wood-working and pattern shops. On account of its small size and weight, this machine can be readily carried by one man, thus permitting it to be transported to any part of the shop

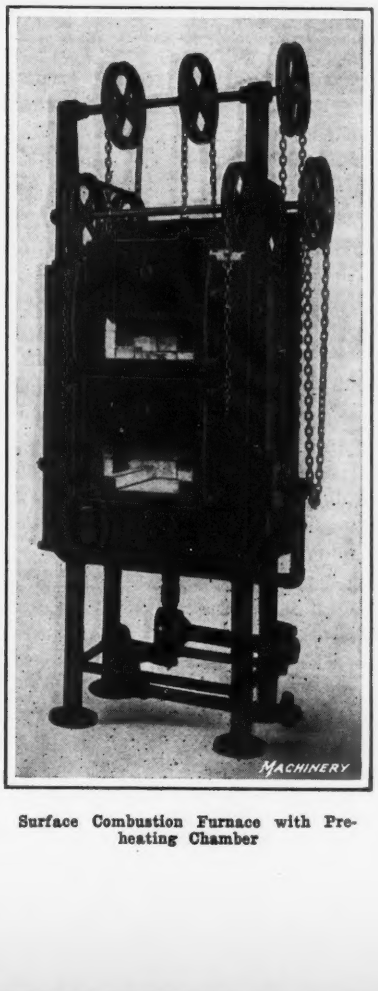
where a machine of this type is required. A feature of the machine is the fence, which is mounted on the motor and slides backward or forward on rods, which allow it to be accurately adjusted. This fence is so designed that only a very small amount of table space is lost when the fence is set for beveling. The motor is connected to the machine in such a manner that the cutter-head can readily be taken out and another head inserted. The tables may be slid away from the cutter-head to permit the use of special heads, or they may be slid forward so as to work with the narrowest possible throat opening. An efficient arrangement of the flap and shutter has been effected by mounting the shutter guard on the cutter-head bearing. The machine is equipped with a motor, lamp cord, and plug for operating from any ordinary lighting circuit.



Bench Jointer made by J. D. Wallace & Co.

SURFACE COMBUSTION FURNACE WITH PREHEATING CHAMBER

In hardening cutters, dies, and other steel tools, there are two dangers to be guarded against. One of these is the possibility of cracking the tools, due to severe internal strains that are set up in the metal, and the other possibility of trouble is due to burning the steel and thus damaging the cutting edges in a way which cannot be corrected by grinding. In a new heat-treating furnace which has been placed on the market by The Surface Combustion Co., 366-368 Gerard Ave., Bronx, New York City, it is claimed that provision has been made for eliminating both of these possibilities of trouble. The strains which cause the cracking of steel during the process of heat-treatment are produced by subjecting steel to rapid changes of temperature. For instance, where a high-speed steel tool is to be heated to a temperature substantially above 2000 degrees F., it would be undesirable to take a cold tool and put it directly into a furnace at this temperature. The better plan is to first preheat the steel to a temperature of, say, two-thirds of that to which the tool will finally be raised. For conducting this preheating operation, the new surface combustion furnace, which is illustrated herewith, has a preheating chamber above the high temperature compartment of the furnace. The design has been worked out in such a way that the hot products of combustion from the high temperature compartment of the furnace are used to raise the preheating compartment to the desired temperature. In this way, preheating is accomplished without any additional operating cost for fuel. It takes a substantially longer time to raise the temperature of a piece of cold steel to 1600 degrees F. than it does to carry the temperature on up from 1600 to 2400 degrees F. For this reason, the hearth of the preheating compartment is made 40 per cent larger than that of the high temperature compartment in which the final heating is accomplished. With such an arrangement, the capacity is sufficient to allow the work to remain in the preheating section longer than in the high temperature section.

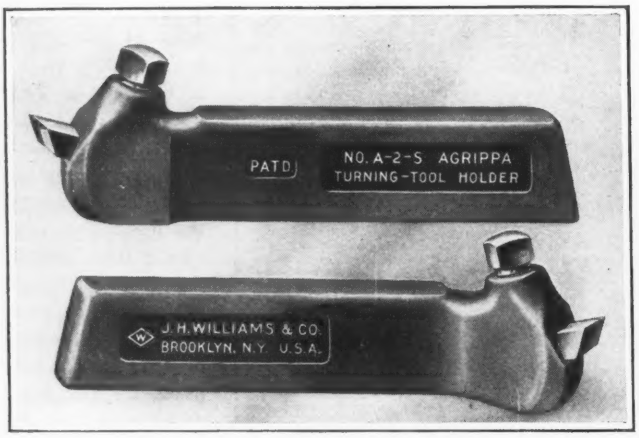


Surface Combustion Furnace with Preheating Chamber

The burning or so-called "scaling" of steel during the process of heat-treatment is caused by the presence of an oxidizing atmosphere in the heating furnace. Various methods have been resorted to in order to overcome this tendency for the steel to burn, such as packing the work, or immersing it in baths of molten cyanide, barium chloride, etc. In all of these cases, the object is to exclude the oxygen of the air so that the heating of the steel may be accomplished in a neutral atmosphere. The same result is accomplished in the furnaces built by The Surface Combustion Co., through the application of a patented one-valve control that mixes air and gas in the correct proportions for obtaining perfect combustion, and maintains these proportions automatically. To increase the heat of the furnace, this valve is opened, and to decrease the heat, the valve is closed. The mixture of air and gas is always accomplished in such a way that there is never an oxidizing atmosphere inside the furnace. Consequently, it is claimed to be impossible for steel that is heat-treated in one of these furnaces to be burned.

J. H. WILLIAMS TURNING TOOL-HOLDERS

In the March, 1915, number of MACHINERY, a description and illustrations were published of the line of "Agrippa" tool-holders which had just been placed on the market at that time by J. H. Williams & Co., 61 Richards St., Brooklyn, N. Y. These tool-holders were furnished with a cam which provided for locking the bit or cutter in the tool-holder. This firm has recently brought out a line of "Agrippa" turning tool-holders, in which a set-screw is employed for clamping the high-speed steel bit in place, and the accompanying illustration shows offset and straight tool-holders of this type. These tools are made with both right- and left-hand offset shanks. Attention is called to the fact that the nose of the holder or shank is beveled to permit the tool to work in close quarters. The shanks are drop-forged from a tough grade of steel, and after forging they are subjected to a method of heat-treatment which not only develops their ability to resist wear, but also imparts the necessary strength to overcome bending stresses. The cutter-holding channel is broached to accurate size, and affords a

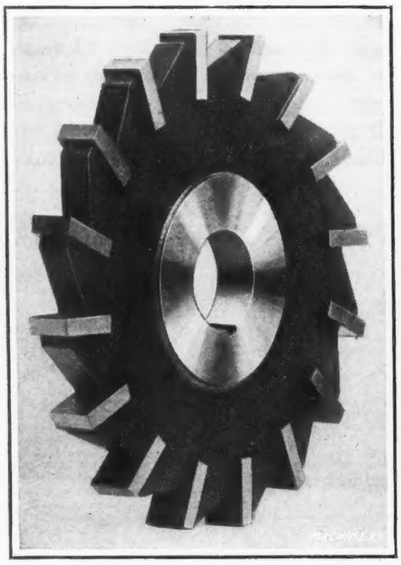


Set-screw Type of Turning Tool-holders made by J. H. Williams & Co.

rigid seat for the cutter. These tool-holders with the set-screw clamping device were developed to supplement the line of holders in which the cam clamping mechanism is employed. Their use is recommended in those cases where the high-speed steel bars from which the cutters are made do not run sufficiently uniform in size, so that dependence may be placed upon the gradual rise of the clamping cam to secure the bit in place. The set-screws are made of alloy steel and they are carefully heat-treated and hardened to give them ample strength and durability.

ARNOLD MILLING CUTTERS

A new line of milling cutters is being made by the H. H. Arnold Co., Rockland, Mass., which consist of high-speed steel blades brazed to alloy steel bodies in such a manner as to produce a solid cutter. The blades are under-cut and ample chip space is provided, so as to remove the greatest amount of material with the least power. As the metal from which the cutter body is made may be machined, the flutes can be remilled when the blades have become worn down, thereby maintaining correct chip space and allowing the cutter to be used for a longer time than would be otherwise possible. Holes can be rebored in the body of the cutter to fit larger sizes of arbors, if necessary. Cutters of this type are made in sizes ranging from 3 inches in diameter and 1/4 inch in width up to 8 inches in diameter and 1 1/2 inch in width. This method of cutter construction effects a decided economy in the use of high-speed steel.



Milling Cutter made by the H. H. Arnold Co.

UNIVERSAL TOOL-HOLDER

The Universal Tool-Holder Co., 1565 E. 17th St., Cleveland, Ohio, has recently developed an adjustable spring-head tool-holder which is suitable for light production and tool work on steel, brass and bronze. It is especially useful for the performance of cutting-off operations, thread-cutting jobs and similar work, as the tool possesses the same utility as the goose-neck type of tool. The clamp holds 5/16-inch round, 5/16-inch square, and 3/32- by 7/16-inch flat bits. The bit or tool can be placed on the right- or left-hand side of the clamp without removing or inverting this clamp. A spring clamp insures that the bit or tool will be in proper alignment. The head of the holder may be adjusted up to 90 degrees, either to the right or left. The shank and spring clamp are forged from nickel steel, and all the parts are tempered, polished, and tested by gages. The tension of the spring is sufficient to permit the cutting of threads from 7 to 40 per inch.

WARDWELL SAW GRINDING MACHINE

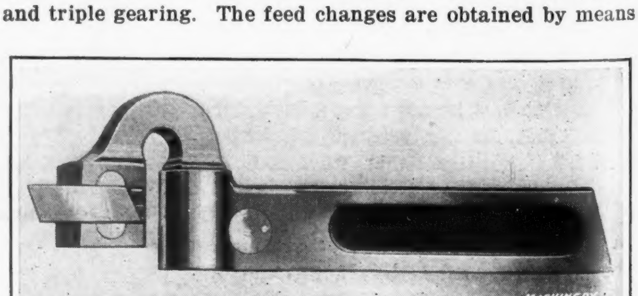
The Wardwell Mfg. Co., 112 Hamilton Ave., Cleveland, Ohio, has placed on the market a Model E automatic metal-cutting circular saw grinding machine. This grinder has been designed for resharpening screw-slotting, slitting, and small cold-saws, ranging from 1 1/2 to 18 inches in diameter and having teeth of any size from 36 teeth to the inch up to 2 inches from tooth to tooth. By using this machine the saws can be resharpened a number of times. The machine is automatic and needs no attention after having been started. The resharpening is done by a bronze-bushed grinding wheel which is suspended at the end of an arm. A graduated slotted eccentric permits an adjustment of the rate of feed, and a double-pawl positive-feed movement gives a continuous feed movement, even in places where the teeth have been broken out of the saw. The machine may be furnished as a bench type or mounted on a column and base. If it is desired to use individual motor drive, a single-phase motor, which takes power from any lamp socket of a lighting circuit of either 110- or 220-volts, alternating or direct current, may be supplied for driving the machine.

MATHISON MACHINE CLAMPS

A line of machine clamps has lately been placed on the market by Albert O. Mathison, 196 Carleton St., New Britain, Conn., which are adapted for holding down work on the tables of planers, boring mills, drilling machines and milling machines; on the faceplate of lathes; and also for holding down press bolsters and fixtures. The clamps are steel forgings and hold the work to the machine by means of a T-bolt. It is claimed that when the work is out of square or taper the clamps will adjust themselves to such conditions, and that they keep the work from slipping when taking a cut at the full capacity of the machine, thus preventing accidents and poor work. The clamps are made in four different sizes, from 4 to 10 inches in length. The T-bolts are not furnished with the clamps, owing to the variations in size of the T-slots on the various makes of machines.

WRIGHT ENGINE LATHE

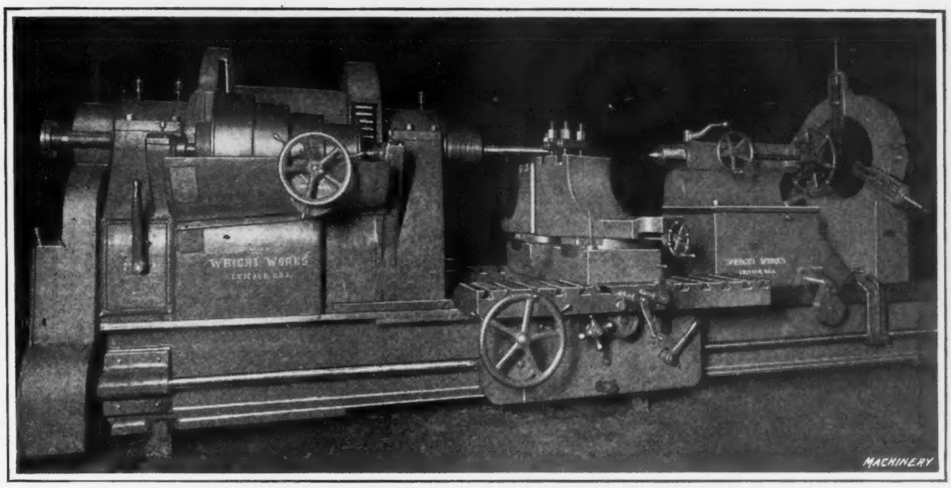
A heavily constructed 96-inch triple back-geared engine lathe which has been produced by the Wright Works, 1150 S. Washtenaw Ave., Chicago, Ill., is here illustrated with the faceplate removed. The machine was designed to be driven by an 8-inch belt which will transmit 40 horsepower to the spindle of the lathe from a countershaft running at 200 revolutions per minute. The lathe is triple back-geared and all speed changes are obtained by moving the handwheel which is placed in front of the cone pulley. Twelve speed changes are obtainable through the four-step pulley and triple gearing. The feed changes are obtained by means



Tool-holder made by the Universal Tool-Holder Co.

of a quick-change gear-box which is integral with the headstock. Two levers on the front of the machine which move in either direction, place the gears in proper mesh, allowing four feeds. Additional feeds may be had by changing the regular feed-gears for the thread-cutting gears.

The carriage is equipped with two compound cross-slides which may be furnished with a power angular feed. The tailstock is moved by hand through the use of a geared device which engages the teeth of a gear with a rack on the bed. The tailstock spindle is moved by a handwheel which is placed at right angles to the spindle. A strongly constructed steadyrest is supplied with each machine. The bed is provided with a rack on a central rib which engages with a pawl on the tailstock, thus removing the thrust of a cut from the clamps of the tailstock to the lathe bed. The maximum distance between lathe centers is 34 feet and the weight of the machine is 150,000 pounds.

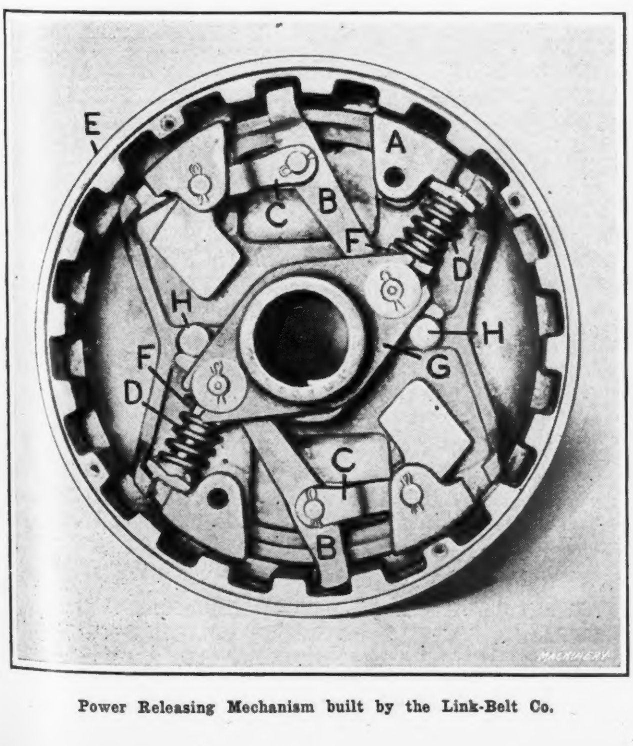


Ninety-six inch Engine Lathe built by the Wright Works

"LETTGO" MECHANICAL OVERLOAD RELEASE

The Link-Belt Co., Chicago, Ill., is manufacturing a mechanical overload release which may be adapted to machines for automatically disengaging the driving power when the load exceeds the capacity of the machine, thus allowing the driving motor or source of power to run free without developing any friction in the releasing mechanism. It is claimed that this device is suitable for overloads which may be either gradually or suddenly applied, and it can be set so that the driving power will not be disengaged by sudden jerks or shocks, such as are received in a punch press or shearing machine. It is possible to install this release close to the driving mechanism of the machine so that it is not necessary for it to overcome inertia due to rotating parts.

The illustration shows a release which has been designed for application to the driving gears of an endless chain bucket conveyer used for handling coal in power houses.



Power Releasing Mechanism built by the Link-Belt Co.

The mechanism is shown with the various parts in position for transmitting power. When the device is connected to a machine the spider *A* is mounted and keyed on the driving shaft of the machine. The triggers *B* are pivoted on links *C*; the outer end of each trigger engages with a notch in the rim of drum *E*, while the inner end of each trigger is held on roller *H* which is mounted on spider *A*. The springs *D*, by means of which the trigger ends are held in the proper position for transmitting power, can be regulated to the desired pressure at which the release is to act, by means of the adjusting nuts *F*. When the machine becomes overloaded the compression of the springs permits the outer trigger ends to become disengaged from the notches in drum *E* thus causing the machine to stop.

In order to set the triggers back to the driving position, the collar *G*, which has fingers that engage with pins on the inner ends of the triggers *B*, is turned by means of a spanner wrench, and the fingers force the outer ends of the triggers back to their original positions in the notches in drum *E*, in this way renewing the connection for the transmission of power. A cover is supplied which encloses the mechanism in such a manner that it can be packed with grease, thus affording lubrication for the operating parts. The device may be driven by means of a wheel or gear mounted on the hub of the drum *E* which may run loose on the driving shaft of the machine; or the drum may be keyed directly to a separate shaft from the one on which spider *A* is mounted, thus forming a coupling device. In any case, either element of the release may drive the machine. A single trigger release has been developed for reversible operation, which is arranged to automatically reset the driving trigger if the direction of rotation is reversed.

NEW MACHINERY AND TOOLS NOTES

Tool-holder: Parker Machine Co., 221 High St., Boston, Mass. A tool-holder which is universal and reversible. It has a positive locking device and will hold any type of bar stock cutters or special shaped cutters. Fifteen cutters are furnished with the holder.

Universal Grinding Machine: Warren F. Fraser Co., Westboro, Mass. Four sizes of universal grinding machines which are of similar design to those described in the August, 1918, number of MACHINERY, except that the new machines are adapted for countershaft drives.

Drilling Machine: Buffalo Forge Co., Buffalo, N. Y. A 25-inch back-geared drilling machine which has eight speeds, and four power feeds, it being also possible to feed the spindle by hand. The travel of the spindle is 14½ inches, diameter of table, 21 inches, and weight, 1550 pounds.

Bearing Oil Wipers: Industrial Products Co., 1024 Penobscot Bldg., Detroit, Mich. An attachment which consists of a triangular shaped piece of babbitt which is held against a shaft by means of a spring that is attached to the bearing or hoist. The babbitt piece wipes the oil from the shaft and returns it to the bearing reservoir.

Die-filing Machine: Bloomfeldt & Rapp Co., 108 N. Jefferson St., Chicago, Ill. A die-filing machine that is operated by a 1/8-horsepower motor. It has a table which may be tilted and clamped at any angle. The over-all dimensions of the machine are 14 inches long, 9 inches wide, and 12 inches high. The weight is 50 pounds.

Shaper: Simmons Machine Co., Inc., Albany, N. Y. A 17-inch single-geared crank shaper which is suitable for general manufacturing work. The main dimensions are as follows: Stroke, 17 inches; size of table, 10 by 13 inches; keyseating capacity, up to 3 inches in diameter; automatic horizontal feed, 13 inches; and weight of machine, 1700 pounds.

Indicator: Osberg & Johanson, 206 Boston St., Dorchester, Mass. An indicator which is suitable for truing up center marks on work to be bored, for testing lathe centers, aligning headstocks and tailstocks of lathes, etc. The device consists of two centers and a scale that is used for indicating the motions of the pointer, the scale being held in a surface gage while being used.

Drill Grinding Machine: Bellevue Industrial Furnace Co., 703 Bellevue Ave., Detroit, Mich. A semi-automatic drill grinding machine which grinds drills on the face of the wheel. It has two carriages and two grinding wheels which are mounted to permit the automatic grinding of either right- or left-hand drills. The machine is suitable for grinding drills with two, three, four, or five lips.

Face Mills: R. W. Runde Machine, Tool & Die Works, 2669 E. Grand Blvd., Detroit, Mich. A line of face mills which have hardened bodies and individual blades that may be adjusted, thus permitting the grinding of the blades by hand without removing the body from the machine. It is possible to use both ends of the blades, and it is claimed that the cutter maintains the original diameter.

Trimming Press: Toledo Machine & Tool Co., Toledo, Ohio. A large single-crank trimming press that has been developed for trimming twelve cylinder airplane crankshaft forgings and other heavy work. The machine has an outer shearing-off slide. It has a stroke of 16 inches and makes seven strokes per minute. The machine is heavily constructed and weighs approximately 185,000 pounds.

Pipe Cutting and Threading Machine: Curtis & Curtis Co., 8 Garden St., Bridgeport, Conn. A hand-operated machine which is capable of cutting and threading wrought iron pipe from 4 to 15 inches in diameter. The die-holder is revolved by a pinion, the shaft on which this is mounted being turned by means of a ratchet lever. A self-aligning vise is located on the back of the machine for clamping the pipe in position.

Power Distributor: Improved Surface Mfg. Co., North Tonawanda, N. Y. "Flex" power distributor, a device used for the application of belt preservative to a moving belt. The device makes it possible to distribute the belt-preserving material to all points of the belt, whether it be large or small. It consists mainly of a tube in which the belt preservative is contained, a small funnel, and a regulator made of wire.

Cutter Grinding Machine: William O. Barnes, Leominster, Mass. A grinding machine that has been designed for grinding gang milling cutters up to 20 inches in diameter. It is capable of grinding single cutters of simple shape or complicated gang cutters with either straight or curved contours. The grinding wheel is driven by a motor and is mounted on a carrier which can slide readily over the surface of the table.

Adjustable Reamer: Wetmore Reamer Co., 210 Sycamore St., Milwaukee, Wis. A line of reamers ranging from 1 to 4 1/2 inches in diameter. The reamers up to 3 inches in diameter have four blades and the larger sizes have six blades. In order to adjust the blades to any required size, a wrench is provided for turning a screw collar which is graduated in thousandths of an inch. The reamer is supplied with or without an arbor.

Lead-burning Transformer: General Electric Co., Schenectady, N. Y. A lead-burning equipment that has been designed for plumbing, roofing, and tank-building jobs. It is operated by a 110-volt alternating-current lighting circuit and can be used for lead-burning, soldering electric terminals, splicing wires and tinsmith jobs. Brazing can be accomplished by placing the work between a blunt carbon point and a piece of cast iron.

Interchangeable Counterbores and Holders: S. & C. Mfg. Co., 368 Mt. Elliott Ave., Detroit, Mich. A device known as the "Easy-Lock" holder which is adapted for holding interchangeable cutters from 1/4 to 3 inches in diameter, in which different sized pilots from 3/16 to 2 1/2 inches in diameter may be inserted. The holders are made in four sizes and may also be used for holding tapered bridge reamers which are manufactured by this concern.

Air or Steam Hammer: Sullivan Machinery Co., People's Gas Bldg., Chicago, Ill. A machine known as the "Utility" hammer which is especially suited for forging cutter bits, chisels, wrenches, small tools, straps, levers, keys, wedges, etc. A wide range of striking power and sensitiveness of blow is obtained by means of an air-thrown valve. Chips are blown from the die by an air exhaust. The hammer may be equipped for operating by either air or steam.

Pressure and Vacuum Pump: Utility Compressor Co., 363 Harper Ave., Detroit, Mich. A pump in which eight pistons are given reciprocating movements by means of a mechanism connected to the pump shaft. The compressor has a capacity of approximately 2 cubic feet of free air per minute, and it will develop pressures up to 300 pounds or vacuums as high as 28 1/2 inches of mercury. The pump is driven by either a direct- or alternating-current motor to which it is connected by a silent chain.

Single Pedestal-leg Lathe: Davis Machine Tool Co., Inc., Rochester, N. Y. A lathe that has a single pedestal leg on which the bed is mounted as a cantilever. It is especially adapted for portable service and is furnished with either belt or motor drive. When it is motor-driven, the motor is attached to the rear of the bed. Some of the principal dimensions are as follows: Length of bed, 6 feet; swing over ways, 13 inches; distance between centers, 42 inches; number of feed changes, 30. The weight is 1481 pounds.

Radius-link Grinding Machine: Newton Machine Tool Works, Inc., 23rd and Vine Sts., Philadelphia, Pa. An improved design of machine that is used in railroad shops for grinding radius links. The vertical spindle revolves in an eccentric sleeve which permits a front and back movement of 1/2 inch. This feature allows a link to be finished without changing the position of the table. The machine is also adapted for grinding straight links and cross-head guides. The grinding capacity is for radii from 24 to 100 inches with work up to 5 inches thick.

Arc-welding Apparatus: United States Light & Heat Corporation, Niagara Falls, N. Y. An arc-welding equipment that has been produced to meet the needs of machine shops, railroads, and shipyards. It may be furnished mounted on a truck or used as a stationary equipment. When connected with 100- to 125-volt direct-current circuits, the welder is in the form of a converter, but on other direct and alternating currents, the welder is in the form of a motor-generator. The capacity of the apparatus is 4 kilowatts. The weight of the stationary equipment is 665 pounds, and of the portable equipment including the truck, 1500 pounds.

Rotary Surface Grinding Machines: Heald Machine Co., Worcester, Mass. A grinding machine that is regularly equipped with either an 8- or 12-inch magnetic chuck, but three-jaw chucks or specially adapted faceplates may be furnished instead. The machine grinds concave and convex surfaces up to an angle of 10 degrees. The chuck may be adjusted for automatically feeding from 0.0003 to 0.0005 inch at each end of the wheel traverse. The machine having an 8-inch chuck is equipped with a 10-inch diameter wheel, and the machine having a 12-inch chuck has a 12-inch wheel, but smaller wheels may be mounted on both machines.

Engine Lathe: Putnam Machine Co., Fitchburg, Mass. A heavy-duty 54-inch geared-head engine lathe. This machine has a friction clutch which is combined with a brake, allowing the machine to be stopped without stopping the motor. If the machine is equipped with a belt drive, this feature permits the machine to be driven directly from a lineshaft. Some of the principal dimensions are as follows: Distance between centers with a 22-foot bed, the tailstock being flush, 9 feet 11 inches, and with the tailstock overhung, 10 feet 8 inches; number of available spindle speeds, 18, ranging from 2.715 to 154.05 revolutions per minute; number of feed changes, 40; weight of machine with a 22-foot bed, 68,300 pounds. The sales agents for this machine are Manning, Maxwell & Moore, Inc., 119 W. 40th St., New York City.

* * *

AMERICAN SOCIETY OF MECHANICAL INSPECTORS

The American Society of Mechanical Inspectors has been organized for the furtherance of mechanical inspection. The temporary headquarters of the society, while awaiting space in the Engineering Societies Building, 29 W. 39th St., is in the Commercial Engineers Building, adjoining. The present membership of the society is one hundred and ten. The officers are as follows: President, Paul E. Theis, factory manager, Fisher Spring Co.; first vice-president, Ernst Mentor, technical supervisor, C. E. Johansson, Inc.; second vice-president, J. Arthur Pineau, chief inspector, Sperry Gyroscope Co.; third vice-president, Benjamin Gilpin, chief inspector, Wright-Martin Aircraft Corporation; fourth vice-president, Herbert L. Bailey, service manager, Chevrolet Motor Co.; secretary, Henry F. Winter, aeronautical engineer; treasurer, H. Ream Baker, mining and civil engineer. The society holds its meetings on the first Thursday of the month. The first copy of its monthly official publication *The Inspector* has just been published.

"FIND-YOURSELF" CAMPAIGN FOR EMPLOYED BOYS

There are few American industrial plants of any size, in which a list of the employes would not reveal the names of many boys who had to leave school at the age of fourteen—as soon as they could obtain a work certificate—in order to earn their own livings, if they were not expected to assist in the support of their parents' homes. As a result of environment, such boys are likely to develop peculiar ideas which often retard their advancement toward a better job; but it is a mistake to think that a majority of these boys who are earning their livings through the performance of semi-skilled labor in a factory, have not the same likes and dislikes, ideals and ambitions, which govern the action of other young people who are more fortunately situated. Realizing this fact, the Rochester Young Men's Christian Association recently inaugurated what has been named a "Find-yourself Campaign for Employed Boys," the object of which is to bring together boys who are employed in a given line of work and men who have sufficient knowledge of such work to be able to advise the boys in regard to courses of study and other matters that will be the means of ultimately fitting them for better positions. This represents a new field of activity, which could be profitably undertaken by Young Men's Christian Associations in all parts of the country; and if carried on to its ultimate conclusion, it should be of great assistance in solving many of the perplexing social and economic problems that now beset the management of many industrial plants in America.

How the Find-yourself Campaign was Conducted

The ultimate object of this campaign is to assist employed boys in selecting a career for which they are well fitted, and then to have successful men in the various businesses or professions in which the boys desire to seek employment undertake to interest themselves in the advancement of one or more boys. The first step in inaugurating the campaign was to send out "self-analysis" blanks which were filled out by the boys and returned to a general committee. These blanks called for complete information concerning the boys' education, habits, home life, etc. The general committee then proceeded to assign the different boys to interviewers, who were, in every case, business men with the necessary experience to enable them to give reliable advice. Each of the men who assisted in this work filled out an "Interviewer's" report on the case of every boy whom he examined. After this preliminary work had been gotten under way, a follow-up or continuation committee was formed, the function of this committee being to keep in touch with, and to give aid and advice to, those boys who showed during their interviews that they were really interested in the proposition and possessed the necessary ambition and other qualifications to benefit by the assistance which they would receive. The work of this continuation committee is quite similar to that of the well-known Big Brother Movement. But there is an important distinction: In the case of the Big Brother Movement, the fundamental idea is to get a man to agree to devote a part of his spare time to looking after the general welfare of some boy who is in need of advice and outside associations, which will help to offset the effect of undesirable conditions at home. The work of the continuation committee of the Find-your-self campaign has these beneficial features, in addition to which it goes a step further, in that the "Big Brother" is a man successfully engaged in the business or profession which the boy desires to follow, and is expected to give him advice concerning methods of study, and help in securing employment, which will assist the boy in attaining the object of his ambition.

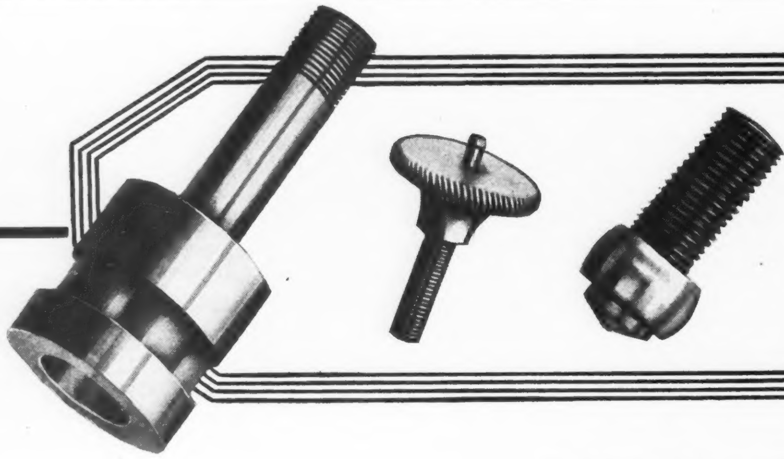
Results of the Preliminary Campaign

Over 150 business and professional men agreed to devote a part of their spare time to the work of this campaign, and during the first week 1366 boys filled out self-analysis blanks, while over 900 were interviewed at offices established for that purpose in various parts of the city of Rochester. Of these, 147 expressed a desire to follow some branch of the engineering profession. It is only natural to expect that among this number of growing boys, there would be many who showed both by their answers on the self-analysis blanks and as a result of their interviews, that they had not yet formed a serious determination to succeed. But such boys were in the minority, as was to be expected, because the kind of boys who would spend an evening investigating a chance of self-improvement are the fellows who are going to be heard of later on in life. A large percentage of these boys were helping to support their parents' homes and were still able to find time to study outside of working hours. If such youngsters fail to get on, it will be through misdirected effort rather than an account of any lack of ambition.

In most cases, the find-yourself campaign met with the hearty indorsement of the parents or older relatives of employed boys; but there were certain exceptions to this general rule. Among reasons advanced for such dissatisfaction, one of the most common was that an effort to guide the boy toward securing a better job would make him dissatisfied with his present employment, with the result that he would leave a good job, which was bringing financial assistance to his family. As the scope of this new work of the Young Men's Christian Association is broadened, some way should be found to assist boys who are at present hindered by such opposition at home. Also, an effort should be made to help those boys whose answers on self-analysis blanks or during the course of their interview, indicated an insufficient determination to succeed. When a boy is forced to leave school at the age of fourteen, and work at a job possessing but little interest, there is nothing very surprising in the fact that he seeks any form of amusement that is available outside of working hours, and is not keen on sitting down to study after his day's work is finished. An effort to make boys of this type settle down to steady work, and the task of helping them to qualify for advancement, would be difficult to accomplish. On the other hand, one is likely to feel that boys who are working under severe handicaps, owing to insufficient education and a poor home environment, are those who naturally make the greatest appeal to the sympathy of men trying to help them overcome these adverse circumstances.

General Summary of Replies of Self-analysis Blanks

The following general summary of the replies which appeared on the self-analysis blanks may prove of interest: Average age of boys, 17 years 5 months; born in cities, 62 per cent; born in foreign countries, 18.7 per cent; born in urban communities, 16.7 per cent; born on farms, 1 per cent; father dead, 15.1 per cent; mother dead, 9.6 per cent; both parents dead, 1 per cent (that is, 25.7 per cent were without natural family conditions); boys who help support their families, 85.5 per cent; boys who are saving a part of their income, 71.2 per cent. There were boys who had left grammar school as early as the second grade, but the number of boys who had dropped out below the fifth grade was less than 1 per cent. Boys who left school upon reaching the fifth grade, 1.97 per cent; sixth grade, 6.1 per cent; seventh grade, 18.2 per cent; eighth grade, 14.8 per cent; graduated from grammar school, 23.3 per cent; graduated from shop school, 3.86 per cent; graduated from technical school, 1 per cent; finished first year of high school, 8 per cent; second year, 6.8 per cent; third year, 4.5 per cent; graduated from high school, 4 per cent. The answers showed that 36.4 per cent of the boys were studying after working hours, and that 29.2 per cent were regularly attending lectures. It was found that boys whose age averaged 17 years 5 months had been working for an average period of two years and three months, and the average number of jobs held by the boys during that period was 2.94. E. K. H.



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FOR ACCURACY

The value of the Screw Machine in producing duplicate parts is recognized as surely as the value of Brown & Sharpe Screw Machines are recognized as the most accurate, versatile machines that can be purchased.
Consider these features that prove our statement:
The automatic chuck advances the stock by a simple movement of a lever and grips it firmly allowing for variations in the size.
The turret is automatically locked at each position of the tool.
There is a self-contained speed and feed box which makes possible the best combination of feed and speed under all conditions.
The back gears are located below the spindle and operated by friction rings.
The many features of this character that have been incorporated in these machines have proved them to be the most economical choice.

A Safeguard for the Operator and the Shop

The operator is protected against mistakes. The shop is assured of quality work when the reliable

Brown & Sharpe Machinists Tools

are found to be the equipment that the operator has in his kit and the shop in the tool room.
Keep up your quality. Send for Catalog 27.

REPRESENTATIVES IN U. S. A.

BALTIMORE, MD., Carey Machinery & Supply Co.
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SAN FRANCISCO, CAL., Pacific Tool & Supply Co.
CLEVELAND, O., DETROIT, MICH., Strong, Carlisle & Hammond Co.
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Offices: New York City, 20 Vesey St.
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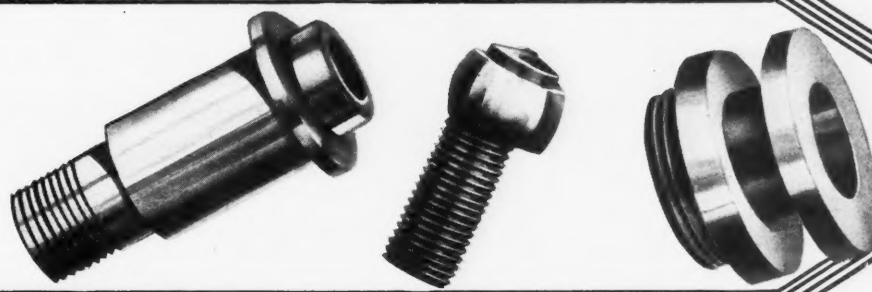

WAY TO DO IT
AND ECONOMY—

Brown & Sharpe
Wire Feed
Screw Machines

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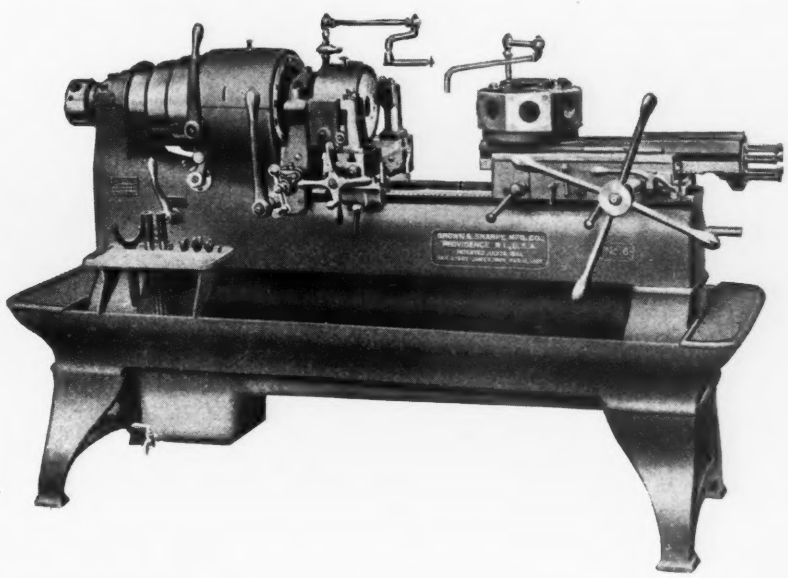
Brown & Sharpe
Wire Feed Screw
Machine



A detailed description
in Catalog 21G

RPE MFG. CO.

R. I., U. S. A.

Rochester, 415 Chamber of Commerce Bldg.
Syracuse, Room 419 University Block
1103-1105 Liberty Bldg. PITTSBURGH, PA., 2538 Henry W. Oliver Building.

REPRESENTATIVES IN CANADA:
Canadian Fairbanks-Morse Co., Ltd.,
TORONTO, MONTREAL, WINNIPEG,
CALGARY, VANCOUVER, ST. JOHN,
HAMILTON.

REPRESENTATIVE IN AUSTRALASIA:
R. L. Scrutton & Co., Ltd., Sydney, N.S.W.

CONVENTION OF THE AMERICAN RAILROAD ASSOCIATION

The joint convention of the American Railroad Association—Mechanical Section—(which embraces the former American Railway Master Mechanics' Association and the Master Car Builders' Association) and the Railway Supply Manufacturers' Association was held at Atlantic City, N. J., June 18 to 25 inclusive. An exhibit was held on Young's Million Dollar Pier, the entire pier being filled with exhibitors of all types of railway equipment. There were more than three hundred exhibitors, and over fifty of the largest exhibits were those of machine tool manufacturers. In the course of the numerous official sessions of the American Railroad Association during the seven days of the convention, considerable time was given to the discussion of reports on many subjects pertaining to car and locomotive design and maintenance. Among these were such subjects as car wheels, couplers, draft gears, car trucks, tank cars, mechanical stokers, locomotive head lights, superheater locomotives; design, maintenance, and operation of electric rolling stock; and many other subjects bearing directly on car and locomotive design and construction. The large exhibit of machine tool builders at this convention indicates how close is the relation between the machine tool industry and the builders of railway equipment. The machine tools represented were of either the heavy class or the type that applies especially to the railroad industry. Many of the machine tools on exhibition were new models that had never been shown at any exhibit previously. A casual study of the latest designs of the machine tools exhibited indicate clearly the tendency toward greater weight, making for rigidity and greater production. The social side of the convention included numerous band concerts, orchestral concerts, and informal dances which were held on the pier. The grand ball was held on Friday evening, June 20. The great number of exhibitors at this convention may well remind us of the important part the railroads of the country occupy as consumers of machine tools when compared with other mechanical industries.

* * *

MATERIAL HANDLING MACHINERY MANUFACTURERS ASSOCIATION'S MEETING

The Material Handling Machinery Manufacturers Association, 35 W. 39th St., New York City, held its semi-annual meeting at the Hotel Astor, New York City, June 10 and 11. A general discussion of the ways and means for promoting a more general knowledge of the economies that can be effected through the use of mechanical handling equipment was conducted. Francis Holley, director of the Bureau of Commercial Economics, made an address on "Educating the World Masses on Industrial Methods by Moving Pictures," in which he pointed out the value of moving picture films as a means of educating the public in the use of mechanical handling equipment as well as other industrial methods. Considerable attention was given to the subject of furthering cooperation between employers and employes. At the open forum session, conducted by David B. Bushnell, problems of trucking and the mechanical handling of materials were discussed.

OBITUARIES

Emory Smith Mills, vice-president of the Muncie Wheel Co., Muncie, Ind., died May 31.

James H. Ball, treasurer of the Lincoln Twist Drill Co., Taunton, Mass., died at his home in Taunton, June 13. Mr. Ball came to Taunton from Boston about twelve years ago as treasurer of the Lincoln Williams Twist Drill Co., and continued as treasurer of the Lincoln Twist Drill Co., which succeeded the older concern on its reorganization. Mr. Ball is survived by his wife and one son.

Benjamin Sebastian, founder of the Sebastian Lathe Co., Cincinnati, Ohio, died at his home in Cincinnati from the effects of a paralytic stroke, June 5, aged sixty-six years. Mr. Sebastian had been a lathe manufacturer for more than forty years, and had retired from business about three years ago, at which time the active management of the business was taken over by his son-in-law, E. E. Stokes.

PERSONALS

H. I. Miner has become associated with the Cleveland Milling Machine Co., Cleveland, Ohio, in the capacity of sales manager.

W. H. White has been appointed acting district manager of sales of the Chicago Pneumatic Tool Co., at Buffalo, N. Y., in place of J. W. McCabe.

Fred J. Miller was nominated for president of the American Society of Mechanical Engineers for 1920 at the spring meeting of the society in Detroit, Mich.

Harry S. Finkenstaedt has returned from the Aviation Service in Italy and is again associated with the Carbon Steel Co., Pittsburg, Pa., as western sales agent.

Charles A. Greene, Chicago representative for the Borden Co., Warren, Ohio, manufacturer of Beaver pipe tools, has opened an office at Room 501, 549 W. Washington Blvd., Chicago, Ill.

H. H. Downes, who was commissioned as captain with the 12th U. S. Engineers, has returned from France, and will take charge of the Buffalo Forge Co.'s interests in the St. Louis territory.

F. G. Echols, for many years general manager of the small tools department of the Pratt & Whitney Co., Hartford, Conn., is now vice-president of the Greenfield Tap & Die Corporation, Greenfield, Mass.

H. L. Van Keuren, formerly chief of the gage section of the Bureau of Standards, Washington, D. C., is now engineer in charge of gages with the Wilton Tool & Mfg. Co., 84 Linden Park St., Boston, Mass.

Cleveland C. Soper has resigned his position as instructor in machine design with the Wentworth Institute, Boston, Mass., and is now associated with the Kent Machine Co., Kent, Ohio, in the capacity of engineer.

F. W. McIntyre, who has been connected for the past sixteen years with the Niles-Bement-Pond Co., of Boston and Chicago, has been appointed sales manager of the Becker Milling Machine Co., Hyde Park, Mass.

E. G. Buckwell, secretary and manager of sales of the Cleveland Twist Drill Co., Cleveland, Ohio, sailed on June 12 for a three or four months' tour of Europe for the purpose of investigating trade conditions throughout England and the continent.

Edwin T. Jackman, formerly of E. S. Jackman & Co., Chicago, Ill., has returned from Sheffield, England, where he has been investigating methods in connection with tool and alloy steels, and is now manager of the Boston office of the Firth-Sterling Steel Co., McKeesport, Pa.

Preston Belvin has been appointed district sales engineer by the International Oxygen Co., 796 Frelinghuysen Ave., Newark, N. J., and will have charge of the Pittsburg district sales work. The Pittsburg office is located at 1310 First National Bank Bldg.

E. B. Gardner, Ralph D. Gardner, C. E. Cadman, and H. I. Kelley have disposed of their interests in the Gardner Machine Co. of Beloit, Wis., and have organized a new company to be known as the Badger Tool Co., Beloit, which will manufacture disk grinders and a general line of grinding machines.

J. W. McCabe, who until recently was district manager of sales for the Chicago Pneumatic Tool Co., at Buffalo, N. Y., has been made special representative for the company's foreign trade department, and will leave shortly for an extended trip through the Orient, the Philippine Islands, and Australia.

Clifford C. Whiting has recently been made manager of the William L. Procunier Co., Chicago, Ill., manufacturer of the "Double Gripp" safety tapping chucks and attachments. Mr. Whiting has served overseas and has just been mustered out of the service. He was formerly with the International Harvester Co.

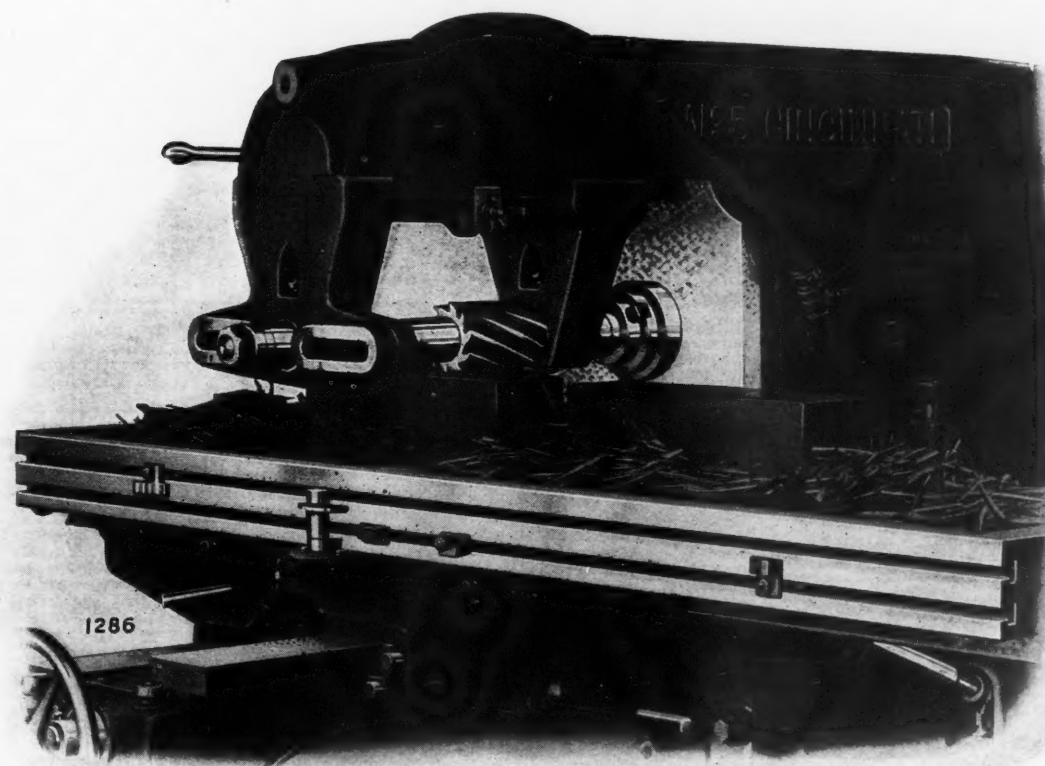
Asher Golden, 311 W. 59th St., New York City, has been appointed by Compagnie d'Applications Mécaniques, of Paris, its exclusive agent in the United States, for the sale of R B F thrust bearings. Catalogues will be issued shortly containing details and specifications of these bearings.

24 Cubic Inches of Steel Removed Without Braces

THE CINCINNATI RECTANGULAR OVERARM

(PATENTED)

enables the new No. 5 machine to take cuts up to its normal rated capacity without the use of braces.



Material, machinery steel, cutter, $4\frac{1}{2}$-in. diameter Cincinnati design spiral mill, 2 in. arbor

Cut, $\frac{1}{4}$-in. deep, 5-in. wide. Feed, 19 in. per minute.

Removing $23\frac{3}{4}$ cubic inches of steel per minute— without the use of braces.

THE CINCINNATI MILLING MACHINE CO.

CINCINNATI OHIO, U. S. A.

C. C. CHEYNEY, who was commissioned in the Navy and had charge of the mechanical repair shops at the Naval Aviation Station, Pensacola, Fla., where from 600 to 1200 men were employed during the war, has returned to the Buffalo Forge Co., Buffalo, N. Y., and will have charge of the Chicago office and store.

ALBERT BRUNT, who for the past four years has been engineer in charge of the direct-current machine design section of the industrial engineering department of the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., has resigned to return to Holland, his native country. Mr. Brunt had been connected with the company since 1909.

W. G. BALPH has been appointed manager of the safety switch section of the Westinghouse Krantz factory, Brooklyn, N. Y. Mr. Balph will have entire charge of the sale of all Krantz products. Prior to working as a salesman in the New York office, Mr. Balph was head of the fan motor division of the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa.

H. L. GARBUTT, for the last six years manager of the line material section of the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., has been appointed manager of the supply division of the Westinghouse San Francisco office. Mr. Garbutt was formerly connected with the Drew Electric & Mfg. Co., of Indianapolis, handling various types of overhead line material.

ALEXANDER LUCHARS, publisher of MACHINERY, sailed for Europe on June 16 as special representative of the United States Department of Commerce. Mr. Luchars was recently appointed United States Trade Commissioner to Great Britain and Continental Europe and will spend several months there studying conditions affecting the sale of American machine tools and supplies. His reports will be mailed promptly to our manufacturers by the Department of Commerce.

F. W. MARSHNER has been appointed manager of the Detroit branch of the New Departure Mfg. Co., Bristol, Conn., succeeding the late Samuel B. Dusinberre. Mr. Marshner has been connected with the company at the Detroit office for about seven years. He is thoroughly acquainted with all details, and will be able to render the same quality of service to customers that has been rendered in the past. Mr. Marshner has been an engineer salesman and consequently has wide acquaintance with the automotive and machinery trades in the West and Middle West.

COMING EVENTS

July 31—Monthly meeting of the Rochester Society of Technical Draftsmen, in Rooms 131-137 Sibley Block, 328 Main St., E., Rochester, N. Y. Secretary, O. L. Angevine, Jr., 857 Genesee St., Rochester, N. Y.

August 19-21—Annual convention of the International Railroad Master Blacksmiths' Association in Chicago, Ill.

September 16-19—Annual meeting of the Traveling Engineers' Association in Chicago, Ill.; headquarters, Hotel Sherman. Secretary, W. O. Thompson, General Offices, N. Y. C. R. R., Cleveland, Ohio.

September 22-27—First annual convention and exhibit of the American Steel Treaters' Society in Chicago, Ill. Business manager, W. H. Eisenman, 154 E. Erie St., Chicago, Ill.

September 29-October 4—Eighth annual congress of the National Safety Council at Cleveland, Ohio.

September 29-October 4—Twenty-fourth annual meeting of the American Foundrymen's Association and fourteenth annual exhibit of foundry and machine shop equipment and supplies in Philadelphia, Pa. Secretary, C. E. Hoyt, 111 W. Monroe St., Chicago, Ill.

SOCIETIES, SCHOOLS AND COLLEGES

Ohio University, Athens, Ohio. Catalogue for 1918-1919, and circular of information for 1919-1920.

Lowell Textile School, Lowell, Mass. Bulletin for 1919-1920, containing calendar, courses of study, etc.

Ogden College, Bowling Green, Ky. Bulletin 1918-1919 containing calendar for 1918-1919 and announcements for 1919-1920.

BOOKS AND PAMPHLETS

Analysis of Statically Indeterminate Structures by the Slope Deflection Method. By W. M. Wilson, F. E. Richart, and Camillo Weiss. 218 pages, 6 by 9 inches. Published by the Engineering Experiment Station of the University of Illinois, as Bulletin No. 108.

The Construction of Graphical Charts. By John B. Peddle, Professor of Machine Design, Rose Polytechnic Institute. 158 pages, 6 by 9 inches; 79 diagrams. Published by the McGraw-Hill Book Co., Inc., 239 W. 39th St., New York City. Price, $2, net.

This book, the second edition of which is now published, describes methods of constructing calculating charts for the repeated application of formulas to different conditions. Many such charts are available for use, but it is obvious that in order to realize their full value, an engineer should be able to construct charts suitable to his individual needs. During the few years that have elapsed since the first edition of this book was published, the use of charts has increased noticeably and gives evidence of the growing recognition of the value of nomography to the engineer. In the second edition of this book a chapter has been added entitled "The Use of Determinants," describing a method of constructing charts which the writer has used successfully for a number of years in his classes. It is the author's belief that anyone with the ordinary knowledge of mathematics which an engineer should possess can understand and apply the process with little difficulty.

NEW CATALOGUES AND CIRCULARS

Gisholt Machine Co., Madison, Wis. Circular of the Gisholt universal tool grinder for grinding tools to the correct cutting angles.

Holt Mfg. Co., Peoria, Ill. Bulletin C-121, describing the Holt "Caterpillar" tractor and giving specifications for the various sizes.

Oliver Machinery Co., Grand Rapids, Mich. Circular descriptive of the Oliver universal sawbench for use in patternmaking shops.

Link-Belt Co., Chicago, Ill. Circular illustrating Link-Belt wagon loaders, portable belt conveyors, and other labor-saving machinery for coal dealers.

Massachusetts Blower Co., Watertown, Mass. Bulletin 51, containing data on fans, exhausters, heaters, air-washers, and other ventilating and heating apparatus produced by the company.

Eastern Production Co., 137 Leib St., Detroit, Mich. Circular 100-Y, illustrating and describing this company's horizontal hydraulic assembly press which is made in two sizes having capacities of 35 and 50 tons, respectively.

Simonds Mfg. Co., Fitchburg, Mass. Catalogue of Simonds crucible and electric furnace steel, giving dimensions and prices of high-speed steel and carbon tool steel plates and bars, and hot-rolled sheet steel.

Buffalo Forge Co., Buffalo, N. Y. Catalogue Section 400, of fans, blowers, and exhausters, describing the design and structural details of the company's equipment, and giving tables of capacities for various speed and horsepower requirements.

American Broach & Machine Co., Ann Arbor, Mich. Circular describing the new type of broaching machines made by this company, which are built in two sizes—No. 1½ and No. 3—capable of handling broaches from the smallest to the largest sizes.

Lodge & Shipley Machine Tool Co., Cincinnati, Ohio. Booklet describing the features of the Lodge & Shipley standard line of lathes, which covers all the requirements of the manufacturing plant, the jobbing shop, and the tool-room, for accurate lathe work.

Chicago Mica Co., Valparaiso, Ind. Catalogue 26 covering the electrical insulating material made by this concern, including molding mica plates, commutator segment plates, commutator rings, special rheostat insulation, tubes, spools, brush-holders, etc.

Skelton Tool Co., Syracuse, N. Y. Circular entitled "Change Speed for Ten Days," calling attention to the time-saving features of the Skelton burring machine, which may be attached to any small drilling machine for burring, reaming, or counterboring screw machine products.

Ingersoll Milling Machine Co., Rockford, Ill. Folder illustrating some classes of work that can be accomplished on Ingersoll milling machines, which are adapted for a wide range of work, being equally suitable for milling heavy castings, steel forgings, and light aluminum parts.

Fafnir Bearing Co., New Britain, Conn. Catalogue 18, of Fafnir ball bearings, describing in detail the construction of the various types. Information is given on methods of mounting, lubricating, etc., and tables are included covering dimensions, prices, and load-carrying capacities.

Charles Engelhard, 30 Church St., New York City. Catalogue P2, containing Bulletins 225, 230, 235, 240, 245, A4, and A5, describing respectively, thermo-elements, protecting tubes and fittings, thermo-couples, indicators and recorders, automatic temperature regulators, and base metal pyrometers.

New Departure Mfg. Co., Bristol, Conn. Bulletin 31 FE containing ball-bearing load charts which give the safe speed of a given bearing carrying a given load, the capacity of a given bearing at a given number of revolutions per minute, and size of bearings required for a given load and speed.

Syracuse Alloy Steel Co., Syracuse, N. Y. Folder giving information relating to the heat-treatment to which "Arab" and "Sasco" high-speed steels should be subjected, in order to give the best results. The folder also contains tables of weight per running foot of high-speed steel of different sections.

Wetmore Reamer Co., 210 Sycamore St., Milwaukee, Wis. Bulletin 11, descriptive of Wetmore expanding reamers with left-hand spiral cutting blades, made in sizes ranging from 1 inch to 4½ inches in diameter. The bulletin gives dimensions and prices of the reamers and their parts—arbors, blades, etc.

P. Pryibil Machine Co., Inc., 512-524 W. 41st St., New York City. Catalogue 19, covering the complete line of woodworking machinery and supplies produced by this company, which includes saws, cross-cut gages, jointers, planers, wood scrapers, sanders, dovetailing machines, tenoners, mortisers, borers, lathes, etc.

Hammond Steel Co., Inc., Syracuse, N. Y. Catalogue 20 containing information on the various brands of tool and high-grade alloy steel produced by this company. The booklet gives the heat-treatment for each brand and the work for which it is especially adapted. A number of useful tables are also included.

Carbo-Hydrogen Co. of America, Benedum Trees Bldg., Pittsburg, Pa. Sectional catalogue containing instructions concerning the proper use of the oxy-carbo-hydrogen process in the cutting of steel and wrought iron, and describing the various cutting and welding torches and tips, regulators, etc., supplied as part of the outfit.

Arrow Tool Co., Bridgeport, Conn. Bulletin 3, entitled "Dependable Thread Gages," describing the thread gages made by this company and giving tables of dimensions and prices. The booklet also illustrates the thread lead testing machine which is used for testing the accuracy of the thread gages made by the company.

Edgar T. Ward's Sons Co., 44 Farnsworth St., Boston, Mass. Catalogue 0-1, giving dimensions of Ward's "Gold Label" high-speed steel. Catalogue 0-2, giving prices and dimensions of "Teenax" non-shrinking tool steel. Catalogue 0-3, containing tables of prices, weights, dimensions, etc., of the seamless steel tubing made by this concern.

Graton & Knight Mfg. Co., Worcester, Mass. Pamphlet entitled "A Study of Various Types of Belting," containing information which was obtained during the course of an investigation on power transmission by belting, conducted by the Mellon Institute of Industrial Research of the University of Pittsburg, for the Leather Belting Exchange.

National Machinery Co., Tiffin, Ohio. National Forging Machine Talk No. 35, describing the making of a camshaft having eight cams, on a National heavy-pattern forging machine. Each of the eight cams required an upset of 3 inches in diameter by ¾ inch thick, and the eighteen inches of stock was gathered in two blows of the machine and two heats.

Cleveland Punch & Shear Works Co., Cleveland, Ohio, has issued a calendar of the working days, arranged by weeks. Each sheet shows samples of the work produced by this company, including punches, dies, nuts, bending machines, shearing machines, etc., and on the back of each page is a specification sheet for use in ordering standard or special punches and dies.

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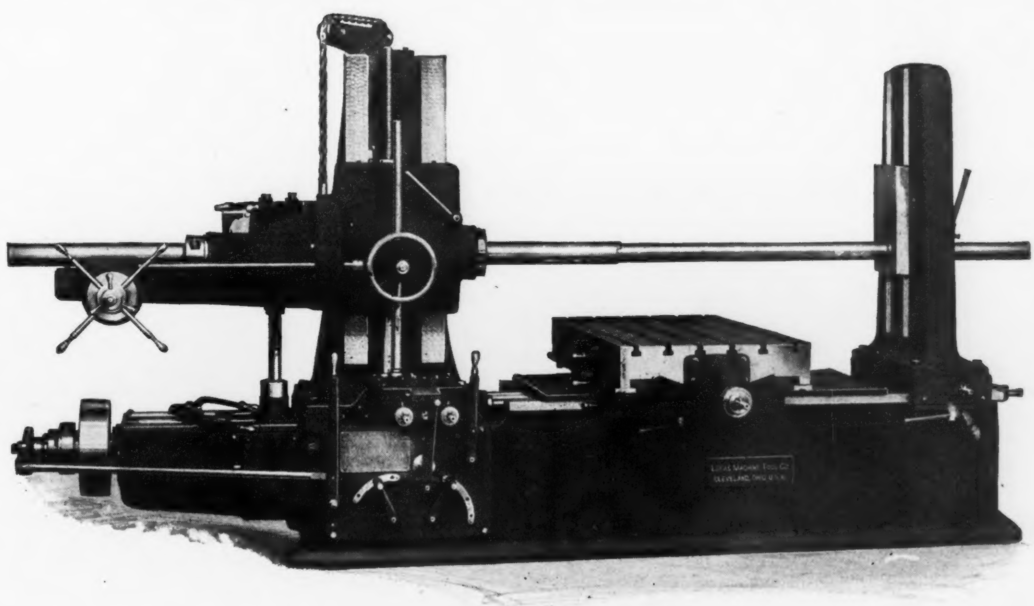

LUCAS MACHINE TOOL COMPANY

NOW AND ALWAYS OF

CLEVELAND, OHIO, U. S. A.

Cement Gun Construction Co., 900 S. Michigan Ave., Chicago, Ill. "Gunite" Book No. 6, illustrating various structures in which "Gunite" concrete has been used to advantage, among which might be mentioned the walls and roofs of industrial plants; bridges and other structures that require protection against corrosion; smokestacks; and linings of coal bunkers, ash bins, mine shafts and tunnels.

Sprague Electric Works of General Electric Co., 527-531 W. 34th St., New York City. Bulletin 48701-A, illustrating and describing Sprague electric dynamometers, as applied to laboratory and production testing of gasoline and kerosene engines. Bulletin 48713, describing the Sprague adjustable loop system, which comprises an overhead mechanical system for handling materials in terminal sheds.

Denham Costfinding Co., Cleveland, Ohio, is distributing a book entitled "The A. B. C. of Cost Engineering," by Robert S. Denham, chief engineer of the company. The book discusses the principles of cost-finding, and gives information concerning the Denham cost engineering service, which provides for the planning and installation of cost engineering systems in factories. The book is distributed free to general managers of factories.

Tide Water Oil Co., 11 Broadway, New York City. Catalogue entitled, "Fuel Oil," discussing the use, economy, and efficiency of fuel oil. The book contains formulas for computing the relative cost of fuel oil versus coal, and comprehensive data on the instruments, tanks, and other appliances that are necessary for its most efficient use. The book is sent without charge to engineers, managers, and plant owners, and to others the price is 50 cents a copy.

Air Reduction Sales Co., 120 Broadway, New York City. Booklet treating of the application of the "Airco" oxy-acetylene welding process to the welding of locomotive fireboxes in railroad repair shops. The booklet describes in detail various welding operations on fireboxes, and is illustrated with full-page drawings showing the different operations. It is virtually a handbook for the use of welders, indicating step by step the method of procedure in making the classes of welds described therein.

Cutler-Hammer Mfg. Co., Milwaukee, Wis. Revised bulletins for insertion in the Cutler-Hammer price book, giving the new prices for motor starters, speed regulators, controllers, magnetic contactors, switches, time-limit overload relays, brake magnets, and rheostats. Folder entitled "C. H. Electric Soldering Irons and Hand Tools," illustrating and describing the standard sizes of electric hand soldering irons made by the company. Attention is also called to an automatic soldering iron rack, and a new soldering fixture.

Taylor Instrument Companies, Rochester, N. Y. General industrial catalogue of "Tycos" instruments for indicating, controlling, and recording temperatures, covering 422 pages 6¼ by 9¾ inches. Many special applications of these instruments are illustrated, showing the manner in which they can be adapted to different temperature needs. Among the instruments illustrated and described are thermometers, hydrometers, pyrometers, temperature and pressure regulators, barometers, and absolute pressure and draft gages.

Allied Machinery Co. of America, 51 Chambers St., New York City. Catalogue descriptive of the line of grinding machines made by the Landis Tool Co., Waynesboro, Pa. The catalogue illustrates and describes plain and roll grinding machines, universal grinding machines, internal grinding machines, ball-race grinding machines, crankpin grinding machines, and camshaft grinding machines. Specifications for the various types of grinding machines are given, covering the dimensions, speed, feeds, horsepower, capacity, etc.

TRADE NOTES

Hydraulic Press Mfg. Co., 84 Lincoln Ave., Mount Gilead, Ohio, has opened a branch office in the Union Bank Bldg., Pittsburg, Pa., with J. E. Holveck in charge.

Peninsular Tool Salvage Co., Inc., Detroit, Mich., has changed its name to the Tool Salvage Co. There will be no change in the organization or policy of the company.

Barber-Colman Co., Rockford, Ill., manufacturer of milling cutters, hobs, and gear-hobbing machines, has opened a branch office at 451 Ellicott Square Bldg., Buffalo, N. Y. C. G. Kaelin is manager of the new office.

International Oxygen Co., 796 Frelinghuysen Ave., Newark, N. J., has removed its Chicago offices, in charge of Philip G. Wesley, from 223 Railway Exchange Bldg. to 817-820 Chicago Stock Exchange Bldg., 30 N. La Salle St.

Lanham Cotton Cultivator Co., Empire Bldg., Atlanta, Ga., is planning to construct a factory for the manufacture of agricultural implements. The company will require equipment for foundry, forge shop, machine shop, wood shop, and paint shop.

Cleveland Milling Machine Co., Cleveland, Ohio, has opened a restaurant in which food will be sold at cost price to the employes of the company. The restaurant was designed with a view of accommodating 300 people, and is provided with up-to-date kitchen facilities.

American Machine Products Co. will move its plant from 21st and Fort Sts., Detroit, Mich., to 18th and Howard Sts., where it will occupy a new two-story factory building, 150 by 200 feet, which will double the company's capacity for manufacturing milling cutters and reamers.

Whitcomb-Blaisdell Machine Tool Co., 134 Gold St., Worcester, Mass., has established an office in New York City at 24 Stone St., for the purpose of handling export business. L. S. Devos, who has recently returned from overseas duty with the American Expeditionary Forces, has been placed in charge of the office.

Badger Tool Co., Beloit, Wis., has been incorporated with a capitalization of $75,000 for the purpose of manufacturing disk grinders and a general line of grinding machines. The incorporaters are E. B. Gardner, Ralph D. Gardner, C. E. Cadman, and H. I. Kelley, all of whom were formerly connected with the Gardner Machine Co. of Beloit.

Wolverine Forged Drill Co., Ypsilanti, Mich., has just been formed to manufacture twist drills made by the forged-flute process, having the shank solid with and of the same material as the fluted portion. The officers of the new company are George J. Crossman, president; Bert Youngs, vice-president; Meyer Kelly, secretary and superintendent; and Burt E. Cook, sales manager.

Niles-Bement-Pond Co., 111 Broadway, New York City, has opened a new office and store at 116 South Ave., Rochester, N. Y. A stock of Pratt & Whitney machinists' small tools will be kept at the new store. The Pittsburg office of the company has been removed from the Frick Building to 425 Seventh Ave. A stock of Pratt & Whitney small tools will also be carried at this office.

Electric Furnace Co., Alliance, Ohio, has recently shipped one of its standard nose-tilting type furnaces to the United States Navy Yard at Washington, D. C., to be used in the government brass foundry there. The furnace is provided with a motor-operated tilting mechanism and has a maximum hearth capacity of 2000 pounds. The shell is 7 feet in diameter and the furnace is rated at 105 kilowatts electrical capacity.

Peck, Stow & Wilcox Co., Southington, Conn., will celebrate its one-hundredth anniversary with a big historical exhibition in that town on August 29 and 30. At the same time the company will also present to the town of Southington, where its oldest and largest plant is located, a soldier memorial in honor not only of the men from Southington who went to fight in the great world war just ended, but also of those who fought in all the other wars of the nation.

Leeds & Northrup Co., Philadelphia, Pa., manufacturer of the potentiometer system of pyrometry, and other electrical temperature-measuring instruments, has opened a pyrometer sales and service department at 1304 Monadnock Block, Chicago, Ill., under the charge of Henry Brewer. Service to pyrometer users and to prospective users will be rendered from this office, and particular attention will be given to maintaining equipment after installation.

Bantam Ball Bearing Co., Bantam, Conn., announces that the employes of the company recently organized the Bantam Ball Bearing Benefit Association, which has for its object the mutual relief and help of any of its members who are unable to work on account of sickness or disability. The following officers were elected: President, Eugene L. Converse; secretary and treasurer, Milton A. Hyatt; directors, Herman Foster, Raymond L. Brown, and Victor Borello.

Bound Brook Oil-less Bearing Co., Bound Brook, N. J., is constructing a new two-story machine shop and office building of concrete and steel construction, 100 by 180 feet. The new building will be located on Lincoln Boulevard, adjoining the present foundry and the Nigrum Impregnated Wood Works. Upon the completion of this addition, the company will have its entire factory located at one point. The contracts for the building have been let to the Austin Co. of Cleveland, Ohio.

Wunsch & Washburn, mechanical engineers, have moved their pattern shops and general offices from 207 Centre St., New York City to 302-304 McDougal St., Brooklyn, N. Y. The pattern shops, which are known as the Paramount Pattern & Model Works, are now located in the building that has been occupied by the machine shop of the company for many years, and may be easily reached from all parts of the city. The engineering offices are located at 487 Broadway, New York City.

Roberts Co., 1049 Drexel Bldg., Philadelphia, Pa., has been incorporated in the state of Pennsylvania for the purpose of carrying on a consulting and contracting engineering business, covering particularly the rolling mill, steel plant, and special machinery fields. A. L. Roberts is president and V. F. Signorelli, secretary and treasurer. Mr. Roberts has had nearly thirty years' experience, specializing in machine design. Mr. Signorelli has been identified with the machinery and engineering business for the past five years and was recently secretary of the Machinery & Machine Products Division of the War Industries Board, Philadelphia Region.

Cooper Hewitt Electric Co., Eighth and Grand Sts., Hoboken, N. J., announces that the General Electric Co., Schenectady, N. Y., has acquired all the common stock of the Cooper Hewitt Electric Co., and the company will hereafter be operated under the regulation and management of the General Electric Co. W. A. D. Evans, who has been connected with the Cooper Hewitt Electric Co. since its inception, is president and treasurer; N. R. Birge is vice-president; C. P. Hamilton, assistant treasurer; and E. E. Davies, secretary and auditor. The present policy of the company in its field of industrial photographic lighting will be continued. Increased facilities will be provided shortly to take care of the rapidly increasing business.

Norton Co., Worcester, Mass., manufacturer of alundum and crystolon grinding wheels and other abrasive products, has opened a store in Detroit, Mich., at 73-75 W. Congress St. In addition to carrying an ample stock of grinding wheels in the Detroit store, the company will expand its service organization. The store and the service department are to be managed by C. W. Jinnette who has represented the Norton Co. in Detroit for a number of years. The sales and demonstrating force will comprise Waldo E. Whiting, William T. Cushing, Lucien Gay, and Dean Wheatley, all of whom have had a special training course at the Worcester plant and experience in laboratory and sales work. The organization will also include special demonstrators from the Worcester factory.

Doehler Die-casting Co., Court, Ninth, and Huntington Sts., Brooklyn, N. Y., announces that the employes of the company have organized an association known as the Doehler Die-casting Employes' Association, for the purpose of assisting employes whose earning capacity is impaired either through sickness or accident, and to provide for their families in case of death. The benefits are based on payments made by the employes, which are duplicated by the company. These benefits do not in any way interfere with those provided by the Workmen's Compensation Law. The employes are publishing a factory monthly called "Doehler Topics," the first number of which contains the message of the president of the company, H. H. Doehler, outlining the plan of the employes' association.

Acme Machine Tool Co. and Greaves-Klusman Tool Co., Cincinnati, Ohio, will be located in the new plant of the Champion Tool Works Co., at Spring Grove Ave. and Winton Place, Cincinnati, which has been purchased by C. H. M. Atkins, B. B. Quillen, and their associates, from H. W. Kreuzburg and A. H. Rosenberg. The buildings are of brick and steel construction, sawtooth roof, located on the main line of the Baltimore & Ohio Railroad, and cover approximately 100,000 square feet of floor space on a tract of land six acres in extent. The purchasers of the property control the Acme Machine Tool Co., the Cincinnati Planer Co., and the Greaves-Klusman Tool Co., and when the Acme and the Greaves-Klusman companies are located in the newly acquired buildings, it is planned to add other buildings to the plant, by which arrangement it is expected to make this concern one of the largest manufacturers of machine tools in Cincinnati, employing approximately 1000 men.

Pratt Chuck Co., Frankfort, N. Y., which for some time has owned the Oneida National Chuck Co., of Oneida, N. Y., operating this company independently, has merged the Oneida business with its own. All business will be transacted from the main office and factory at Frankfort, and the Oneida plant will be operated as a branch factory. The Oneida factory will be utilized for the manufacture of Pratt-Oneida lathe chucks, and will specialize in making the steel reinforced design of chuck. At the Frankfort plant the Pratt-Oneida line of drill chucks will be produced, a specialty being made of the positive-drive type. The officers of the Pratt Chuck Co. are: Richard U. Sherman, president and treasurer; George H. Sicard, vice-president and general manager; and Charles Millar, secretary. The directors consist of the officers and H. M. Reynolds and J. F. Maynard. A New York office and stock-room has been opened at 39 Cortlandt St., and a Chicago office and stock-room at 557 W. Monroe St. At each of these offices, a full line of Pratt-Oneida chucks will be carried.

Youngstown Pressed Steel Co., Youngstown, Ohio, which is now operating factories in East Youngstown, Haselton and Sharon, has acquired a tract of land of approximately forty acres in Warren, Ohio, on which it will build a new plant for the purpose of consolidating the three factories which they are now operating in one works. The new plant will be nearly four times as large as the combined area of the present factory, and will comprise 291 by 200 square feet of floor space. The buildings will be of one-story construction, fireproof throughout. Between five and six hundred men will be required to operate the plant at its full capacity. It is the intention of the company to add new lines of steel products as rapidly as possible. At present, the products include all types of pressed steel parts for automobiles, tractors, implements, trucks, and any special requirements where castings and forgings have previously been used. The erection of the new plant will commence at once. The officers of the company are W. W. Galbreath, president; W. G. Kranz, vice-president; A. J. Watson, secretary-treasurer; and W. J. Powell, general superintendent.

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